

NYASALAND PROTECTORATE



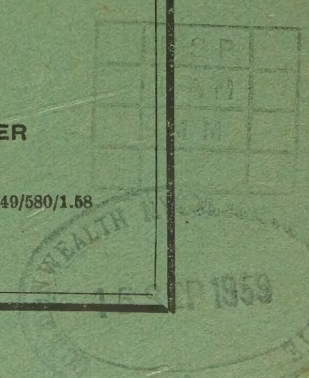
Annual Report
of the
Department of Agriculture
for the
Year 1956/7
(PART II)

PRICE 6s-6d

1958

PRINTED AND PUBLISHED BY THE GOVERNMENT PRINTER
ZOMBA, NYASALAND

AGRIC. 14349/580/1.58

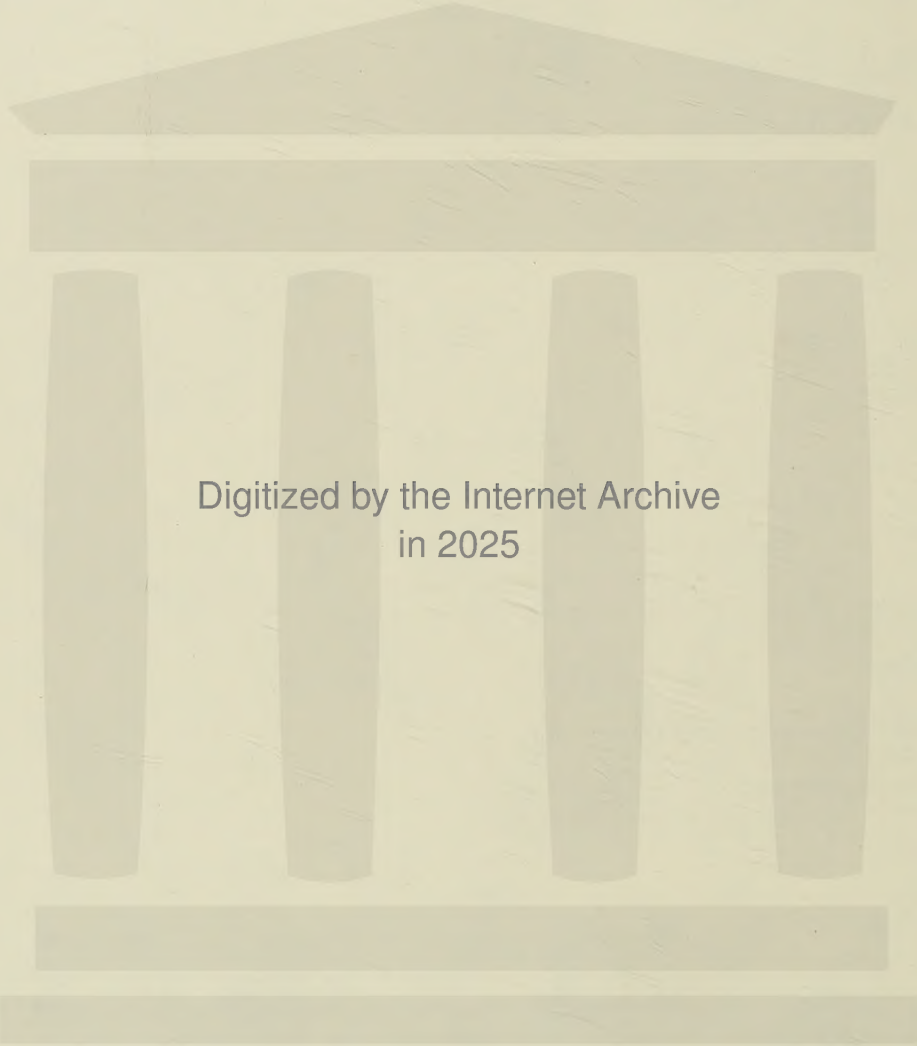


DEPARTMENT OF AGRICULTURE

ANNUAL REPORT FOR THE YEAR 1956/57

(PART II)

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INTRODUCTION

This Report continues past practice of collecting together the results of all experimental work undertaken by the Department of Agriculture during the preceding year. It is an important document both because of the range of subjects covered and the depth of investigation and it can be claimed that, generally speaking, agricultural knowledge is ahead of practice, which is at it should be.

A striking thread running through the Report is the immense importance of nitrogen. This is not new, but the potential consequences of the much wider and more knowledgeable use of nitrogenous fertilizers are yearly becoming more impressive. There is much that is not yet understood of the causes of crop behaviour and response to nitrogen, but the effects are clear enough to give a definite guide to agricultural policy.

Nowhere in Nyasaland is the application of this knowledge more important and urgent than in food production, particularly maize. The population pressure, steadily increasing, is already such that thousands of acres are cropped continuously to maize. Understandable fear of food shortage, aggravated by each new mouth to feed, precludes the introduction of crop rotation as the first remedial step. Nitrogen provides the key to the solution of this problem. Experiments described in this Report indicate that the application of very modest dressings of sulphate of ammonia will, in the majority of cases, produce an economic increase in maize yields sufficient to release enough land to allow of the introduction of a simple rotation. Other experiments also described in the Report continue to show the profound effect of groundnuts on maize and other crops following, so that the advantage gained initially by nitrogen can be further exploited by a crop which, in addition to other merits, is economical in its nitrogen consumption.

That would be a remarkable step. It is at a more advanced stage in the evolution of a farming system that nitrogen again appears to be an essential key. The advantages of livestock from many points of view are obvious. Knowledge of the value of farmyard manure in various forms is increasing from experiments: but cattle need grass and grass leys must apparently have nitrogen added to them, and so must the crops that follow them, if the full contribution of leys to greater productivity is to be realized. The local work begun on this subject needs to be continued and the economic implications of it carefully studied.

But the story of nitrogen running through this Report is not wholly of a need for more. In the case of flue-cured tobacco some important evidence is accumulating that it is frequently excessive, and the cause of loss of quality. This is due to the higher intrinsic fertility of Nyasaland soils as compared with the general run of tobacco soils in Southern Rhodesia, and emphasizes the need for more local research.

The Tobacco Research Board of Rhodesia and Nyasaland has not yet begun investigations in Nyasaland, but local resources can make an important contribution to the solution of this problem and the work described in this Report is a promising beginning.

Another aspect of the investigational work for increased productivity and the greater output of food described in this Report is the maize breeding programme. It is long term work as a rule, but it is encouraging to see that the flint types on which the programme is based are of greater nutritive value than the dents. This advantage added to that of higher resistance to insect damage under primitive storage conditions makes the type particularly suitable where maize is grown almost entirely by Africans for local consumption and not for export. And, incidentally, it supports with facts and figures the preference which African cultivators have shown for many years.

LIST OF EXPERIMENT STATIONS AND STAFF LIST

The experiment stations in operation during the period under review, and the officers who have been in residence are listed below:—

Agricultural Research Station, Chitedze, Box 158, Lilongwe

Chief Agricultural Research Officer	..	S. T. HOYLE, O.B.E., M.A.
Agricultural Officer (Tobacco)	..	J. W. DRUMMOND, B.S.C. HONS (EDIN)
Agricultural Officer (Agronomist)	..	P. BROWN, B.A. (CANTAB) D.T.A. (TRIN)
Plant Breeder	.. ..	R. T. ELLIS, B.S.C. (LOND) DIP. AGRIC SC. (CANTAB)
Agricultural Chemist	..	R. A. WOOD, B.S.C. (MANCH)
Assistant Chemist	.. ..	W. D. CHONA, B.S.C. (RHODES)
Farm Manager	.. ..	P. F. LARKINS

Tea Experiment Station, Mimosa, Mlanje

Senior Tea Research Officer	..	D. L. DOWNIE, B.S.C. (EDIN)
Tea Research Officer	..	D. H. LAYCOCK, M.S.C. (LEEDS) A.I.C.T.A.
Horticulturist	.. ..	I. P. SCARBOROUGH, DIP. HORT.
Farm Manager	.. ..	G. A. BRIDGER

Bvumbwe Tung and Agricultural Experiment Station, Box 48, Limbe

Agricultural Officer	.. ..	L. J. FOSTER, B.S.C. (READING)
Agricultural Chemist	.. ..	C. V. CUTTING, B.S.C. (LOND) A.R.I.C. PH.D.
Laboratory Technician	.. ..	R. C. PEAK
Farm Manager	.. ..	E. FABIAN

Tuchila Experiment Station, Box 28, Luchenza

Officer in Charge		A. E. PREECE, N.D.A., D.D.D., S.D.A.
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Makanga Experiment Station, Chiromo

Cotton Specialist (E.C.G.C.)		J. M. MUNRO, B.S.C. (EDIN)
Farm Manager		D. F. COLLINGS, C.D.A.

Mwera Hill Experiment Station, Dowa

Officer in Charge		I. K. MSISKA
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Chitala Experiment Station, Salima

Officer in Charge		W. EDWARDS, C.D.A.
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Mbawa Experiment Station, Mzimba

Officer in Charge		F. HIGSON
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Provincial Agricultural Officers

Southern Province		R. SMITH, B.A., DIP. AGRIC. (CANTAB) A.I.C.T.A.
Central Province	.. ..	H. W. T. WEBB, B.S.C. (MCGILL)
Northern Province	.. ..	J. A. SANDYS, B.S.C. (NOTTINGHAM)

Headquarters, Zomba

Entomologist	..	..	..	G. HEATH, B.SC. AGRIC. (DUNELM) PH.D. (LONDON)
Ecologist	..	..	..	G. JACKSON, B.SC. (HONS) (SHEFFIELD) DIP. AGRIC. SCIENCE (CANTAB)
Plant Pathologist	..	..	..	D. C. M. CORBETT, B.SC. (HONS) (ABERD) DIP. AGRIC. SC. (CANTAB) D.T.A. (TRIN)

Cotton Pest Research Scheme

Officer in Charge (Gatooma)	..	..	T. P. TUNSTALL, B.SC. (HONS) DIP. AGRIC. (READING), A.R.C.S.
Entomologist (Makanga)	..	..	R. C. H. SWEENEY, F.R.E.S.

MAIZE

Breeding Work

1. INBREEDING

The most advanced group of locally produced inbred lines which grew as S.8 plants are now quite uniform. After further selection only 40 lines remain out of 360 at the S.3 stage. Mainly, by virtue of susceptibility to leaf diseases, caused by *Helminthosporium turcicum* and *Puccinia sorghi*, the number of lines remaining in the less advanced groups of inbreds have been severely reduced. Much extremely promising new material is, however, available from a country-wide collection of maize made by the field staff. This was made on the basis of large cobs, *with white flinty grain and well covered by the husks*, and should represent at least a sample of the best material in the country.

Of the existing inbred lines seven local and one introduced selected on the basis of combining ability, disease resistance and field appearance were crossed together in all possible combinations. This will form Synthetic Variety No. 9 which represents the probable limit of what can be achieved with these established inbred lines from local material when they are used in predominating proportions. The present indications are that better results are likely from a large proportion of introduced material but with sufficient local inbreds to maintain the desired keeping quality.

2. MAIZE COLLECTION

The collection, made in 1954 as being a random sample of maize from all parts of the country, was maintained and further studied.

3. YIELD TRIALS

This season all yield trials except the main variety trial were grown with single plants at one-foot intervals along the ridge instead of hills of three plants at three-foot intervals, the ridges in both cases being three feet apart. It has been found previously that this new spacing made it easier to establish a perfect stand for each plot and that growth was more even. This enabled the size of plot to be reduced to as little as 15 plants in some trials and at the most 24 plants.

From this followed many advantages, such as low seed requirements enabling strains in short supply to be tested, small size of blocks allowing for more replications and for blocks to be fitted into more compact and uniform areas and ease of planting and weeding. There is also an indication, as yet unconfirmed, that maize planted singly has less tendency to lodge than when grown in hills of three plants. Coefficients of variation ranging from 2.8 per cent. to 16 per cent. (experiment damaged by cattle) were obtained in experiments of this layout.

4. TEST TOP CROSSES

There were 60 top crosses made in 1955/56 between inbreds and Namalenga and these were tested in yield trial. The highest yielding cross gave the equivalent of 5,152 lb. grain per acre and the lowest 3,802 lb. All the surviving groups of inbreds

have now been tested at least once and many have been retested. The results of this series of top crosses yield trials which has now run for five years has been reasonably consistent. Namalenga has been the tester parent throughout and the combining ability with this has now been well established for the main groups of inbred lines. As the final aim is a flint combination, the local flint Synthetic Variety No. 7 will be used in future as the tester parent.

5. SINGLE CROSS HYBRIDS

The series of single crosses made in 1955/56 were tested in a yield trial in which the top yielding crosses of the 1955/56 trial were included, making 125 treatments. This was an extremely well grown trial and from its total area of 0.775 of an acre an equivalent of 6,566 lb. of shelled grain per acre was harvested. It was reported from the 1955/56 trial that crosses with the Southern Rhodesian inbred N.2656 had been disappointing. This could certainly not be said of the present trial, as crosses with this inbred were quite outstanding in the field for their vigour, evenness, standing ability, disease resistance and size of cobs, and at harvest for their total weight of grain. The top yielding cross was that between the local inbred R.5126 and N.2656 with 9,526 lb. grain per acre and the next was the reciprocal cross with 9,092 lb. Unfortunately the tip coverage and grain type of this cross was not acceptable but the cross between the related inbred R.5125 and N.2656 which yielded 8,932 lb. grain per acre had better tip coverage with perfect cob formation and the grain a good medium flint. Two other crosses L.5084 $\times$ N.2656 (8,398 lb. grain per acre) and N.2656 $\times$ N.5191 (8,377 lb. grain per acre) also fulfilled the requirement of very high yield with good field and cob characteristics.

Also outstanding was a cross between a local inbred and a strain received from the Rockefeller Foundation Maize Breeding Programme in Mexico, which had headed the yield trial in 1955/6. This is an extremely vigorous but rather coarse-growing hybrid, tall but of good standing ability due to very strong roots and stem. The cobs are well covered and the grain flinty but the shelling-out percentage is only 64 per cent. due to a very thick rachis. The yield of grain was nevertheless 8,389 lb. per acre. Another Mexican line JV.53 H.505, crossed with the local inbred R.4119, which was eighteenth in the 1955/6 trial was nineteenth in the present trial with 7,259 lb. grain per acre and acceptable cobs and grain.

The top yielding hybrid between two local inbreds L.5084 $\times$ N.5192 gave 7,902 lb. grain per acre.

The open pollinated variety Namalenga gave 5,902 lb. grain per acre.

The coefficient of variation of the trial was 12 per cent. and the least significant difference 894 lb. of shelled grain per acre.

A further series of crosses are being made to incorporate the best material as shown by this trial into synthetic varieties.

6. VARIETY TRIALS

Variety trials were conducted at Chitedze, Mbawa, Tuchila, Chitala and Makanga. At Chitala, due largely to a severe attack of *Striga lutea*, yields were very low and there were no significant differences. At Makanga the trial was planted so late that yields were extremely low although significant differences did appear.

TABLE I
Maize Variety Trial
Yield of Grain (lb./Acre)

	<i>Chitedze</i>	<i>Mbawa</i>	<i>Tuchila</i>	<i>Makanga</i>	<i>Chitala</i>
Synthetic No. 8F1	4,478*	—	—	—	—
Top Cross 26	4,258*	3,322*	3,626*	500	1,394
S. Rhodesian Hybrid (N3 x A5) (T4 x M9)	4,247*	3,085*	3,976*	300	1,317
Namalenga	3,963	2,628	3,200	442	1,336
Local Hybrid No. 2	3,904	3,157*	3,594*	375	1,329
Synthetic No. 7	3,758	3,575	2,949	394	1,042
Local Hybrid No. 3	3,624	3,024*	3,490*	503	1,572
Double Top Cross 26 x 28	3,623	2,726	3,175	397	952
Synthetic No. 2	3,584	3,360*	3,222	581	1,176
Synthetic No. 6	3,534	2,967*	3,093	350	1,054
Synthetic No. 5	3,239	2,599	2,712	308	848
Local Unselected	3,189	2,209	3,446	909*	935
Synthetic No. 1	—	2,233	—	—	—
Makanga Selection	—	—	—	937*	—
Chitala Selection	—	—	—	—	970
Least significant difference (P=0.05) ..	295	441	520	112	No
					significance
Mean yield	3,739	2,810	3,321	425	1,160
C. of V	6.8%	13.6%	13.5%	19.4%	48.8%

* Top Yielding varieties not differing significantly from one another.

Top Cross 26 again did very well to have equalled the yield of the Southern Rhodesia Hybrid at all stations, but it has been decided that its yield is not sufficiently in excess of Namalenga to justify its production as a commercial top cross. Synthetic Variety No. 8 consists of a mixture of single crosses between local inbreds and Southern Rhodesian inbreds. Because of the large proportion of Southern Rhodesian material the general keeping quality of this synthetic is poor but it is proposed to practice mass selection with the object of improving this.

The two local double cross hybrids with a strictly flint type of grain and good tip coverage yielded quite well. Synthetic No. 7 is also of this same type and its yield was not significantly different from that of Namalenga; at the Colby School of Agriculture on a plot of $2\frac{1}{2}$ acres it gave 48 bags of grain. Namalenga did not have a good year and nowhere was in the top bracket of significance but is still the best open pollinated variety available.

The results from Makanga confirm that Makanga Selection and the local village strain are well adapted to the area, this being particularly marked when conditions are very adverse.

7. RECURRENT SELECTION

A second cycle of recurrent selection was completed on the progeny of a number of vigorous plants selected from a bulk of local maize. As in the first cycle (Annual Report, 1954/55) the yield of the best strain fell short of that of Namalenga by 6 per cent. and it would appear that no further improvement is possible in this material by this method.

A first cycle of recurrent selection was completed on Synthetic Varieties No. 1 and No. 2. A number of strains exceeded Namalenga significantly and will be reconstituted as the improved synthetic varieties.

8. SYNTHETIC VARIETIES IN ADVANCED GENERATIONS

Two trials were carried out with the main object of assessing the behaviour of synthetic varieties of hybrid origin in advanced generations. In the first, two top crosses were compared in all generations from F.1 to F.4.

TABLE II
Yield Trial of Top Crosses in Advanced Generations
Yield of Grain lb. per Acre

Top Cross 229	F. 1	..	..	..	..	..	3,480
	F. 2	..	..	..	..	..	3,056
	F. 3	..	..	..	..	..	2,722
	F. 4	..	..	..	..	..	3,187
Top Cross 223	F. 1	..	..	..	..	..	2,981
	F. 2	..	..	..	..	..	2,803
	F. 3	..	..	..	..	..	2,489
	F. 4	..	..	..	..	..	2,887
Namalenga ..	..	..	..	..	..	..	2,808
L.S.D. ..	..	..	..	..	..	..	443
C. of V. ..	..	..	..	..	..	..	13%

In the other trial the synthetic varieties so far available were compared.

TABLE III
Synthetic Varieties Yield Trial
Yields of Grain (lb./acre)

Synthetic No. 1	F. 2	..	..	..	..	..	2,381
"	" 1 F. 3	..	..	..	..	..	2,520
"	" 2 F. 4	..	..	..	..	..	2,634
"	" 3 F. 1	..	..	..	..	..	3,039
"	" 4 F. 1	..	..	..	..	..	2,551
"	" 4 F. 2	..	..	..	..	..	2,093
"	" 5 F. 1	..	..	..	..	..	2,671
"	" 5 F. 2	..	..	..	..	..	2,472
"	" 6 F. 1	..	..	..	..	..	3,578
"	" 6 F. 2	..	..	..	..	..	3,027
"	" 7 F. 1	..	..	..	..	..	3,419
"	" 8 F. 1	..	..	..	..	..	4,520
Local Hybrid No. 2	..	..	..	..	..	..	3,619
Namalenga ..	..	..	..	..	..	..	3,423
L.S.D. ..	..	..	..	..	..	..	455
C. of V. ..	..	..	..	..	..	..	4.3%

As in previous years there is no suggestion from these trials of a steady or progressive decline in yield in advanced generations after the F.2. It will be noticed that the yield of the higher numbered and later made synthetics is greater than those of the earlier ones.

9. IRRIGATED MAIZE

Facilities have now become available for growing maize on two plots of about 400 square yards each, irrigated by borehole water at Chitala Experiment Station on the Salima Lake-shore. It is warm enough there for maize to grow well throughout the dry season but as our maize requires at least $5\frac{1}{2}$ months to come to maturity there is only just time for two generations to be grown in one year. From May to November, 1956, two single crosses were successfully made on a large scale. In 1957 the work has consisted of a large number of crosses which have been made by artificial pollination.

About 1,500 square yards of irrigated land are also available for maize at Makanga Experiment Station, Chiromo. In 1957 the work there has been a yield trial, observation and selfing rows and an increase plot all of *Puccinia polysora* resistant maize.

10. RUST DISEASES

The common rust *Puccinia sorghi* was as usual widespread. Scoring on a scale of 0 to 5, an average of 1.5 was recorded for 130 strains and varieties at Chitedze. Some inbred lines, when inoculated with diseased leaf material, showed themselves to be very susceptible.

Puccinia polysora rust was severe in the Balaka area and at Makanga Experiment Station, Chiromo. It was widely distributed in the Lower River area but its severity was limited by the poor growing conditions under which wet season maize is grown in that area.

A survey, conducted in the Lower River in June, showed that *Puccinia polysora* had virtually disappeared by this time, and was not even to be found on the irrigated maize trial at Makanga. The rust has disappeared at approximately the same time for the last two years, and does not appear again until December or early January. At Chitedze it appeared on the very susceptible Southern Rhodesian Hybrid but on no other maize there. As the disease does not occur in severe form at Chitedze, breeding for resistance for it cannot be carried on from there alone. In 1954/55 and 1955/6 E.A.A.F.R.O. strains, carrying some resistance and a large number of crosses between them and local material, were tested under severe field conditions of infection at Balaka and it was only possible to recover grain from resistant but open pollinated plants. Of these 11 strains were selected which had shown good resistance for two years and had also produced heavy cobs with good grain type and tip coverage. Also taken were six crosses between E.A.A.F.R.O. strains and the open pollinated variety Makanga Selection which were top yielders in a previous trial of a series of such crosses. It was expected that all of these 17 strains would show a segregation for resistance to *Puccinia polysora*. A line of 24 plants of each of them was therefore grown at Makanga and as the disease was not expected to develop fully until after flowering, all plants were selfed. The strains were also entered in yield trials at Makanga and Chitedze. Details of the strains and their performance are given in Table IV below:

TABLE IV
Puccinia polysora Resisters Yield Trials and Disease Scores

Serial No.	Strains	Yield lbs. grain/acre		Number of plants (out of 24) showing resistance at Makanga	
	Origin	Makanga	Chitedze	Complete	Partial
—	Makanga				
1	Selection × AFRO5342	2,300*	5,050	4	2
2	„ × (AFRO 5328 × R.3363)	2,660*	5,326	4	2
3	„ × AFRO 5327	2,005	4,553	1	1
4	„ × (AFRO 5318 × L.3198)	2,458*	5,082	2	2
5	„ × AFRO 5332	2,473*	5,633	1	1
6	„ × (AFRO 5343 × R.3373)	1,570	4,966	3	1
7	AFRO 5327 OP × 2	1,930	4,288	1	3
8	„ 5310 OP × 2	1,815	4,828	2	1
9	„ 5342 OP × 2	2,568*	6,776*	4	3
10	(„ 5342 × R.3313) OP × 2	1,853	4,500	1	1
11	(„ 5369 × R.3309) OP × 2	1,865	5,453	4	2
12	(„ 5328 × R.3363) OP × 2	1,853	5,378	6	1
13	(„ 5338 × R.3238) OP × 2	2,115	5,378	2	2
14	(„ 5310 × R.3238) OP × 2	1,690	4,521	2	1
15	(„ 5353 × R.3363) OP × 2	1,773	4,394	2	6
16	(„ 532 × R.3200) OP × 2	2,000	4,415	5	2
17	AFRO 54447 OP × 1	2,515*	5,887*	6	—
18	Makanga Selection (Control)	1,770	4,648	—	1
	L.S.D.	498	953	—	—
	C. of V.	18%	16%	—	—

* Top yielding crosses not differing significantly from one another.

The selfed cobs from rust-free plants of the highest yielding strains were examined and eight were selected as having a hard flint or medium flint grain and good tip coverage. A sample of twenty grains for each cob was set aside to be planted as a row for further selfing and testing for *Puccinia polysora* resistance. The remaining grains from the eight cobs were mixed and sown together as a bulk with irrigation at Makanga in April, 1957.

The resistance to *Puccinia polysora* present in the E.A.A.F.R.O. material is said to be conditioned by a dominant major gene. Assuming that the self-pollinated resisters which provided the seed were heterozygous for this gene and that free inter-pollination now occurs between the plants, the seed harvested from this bulk will contain 25 per cent. homozygous resisters, 50 per cent heterozygous resisters and 25 per cent. homozygous susceptibles and this proportion should maintain itself in future generations. To decrease the proportion of susceptibles, further selfing would be necessary in conditions of infection. This would result in loss of yielding ability and a large programme of testing and recombination would be required. In view of the very good yield of the strains comprising the bulk, especially at Makanga where Makanga Selection has previously been unsurpassed, it is considered that the proportion of 75 per cent. resisters in it is an acceptable one in present circumstances.

11. LEAF BLIGHT

Leaf blight caused by the fungus *Helminthosporium turcicum* was again the most important disease of maize in the main growing areas. The above-average rainfall was favourable to the disease. The average score for all the varieties and plots at Chitedze was 2.8 (Jenkins & Elliott scale 0 to 5) which corresponds to a moderate infection. All the inbred lines and material being tested for *Helminthosporium turcicum* resistance was inoculated with diseased leaf material; this caused a very heavy attack and susceptible lines were prematurely killed and produced little or no grain on the cobs.

Thirteen strains with resistance were received from the Natal Agricultural Research Institute; these together with ten local inbreds were tested with heavy inoculations of diseased material. Most of the lines showed very good resistance and a number of crosses were made to the inbred of Top Cross 26 and to another good line L.4053 as the first step to transferring resistance to these lines.

<i>Lines ex Natal</i>							<i>Score</i>	<i>Local Inbreds</i>	<i>Score</i>
E 2683 P ..	..	..	..	..	..	..	2.0	L 6001	1.0
K 64 (recovered)	..	..	..	..	..	..	1.0	L 6006	1.5
D 180 P ..	..	..	..	..	..	..	1.0	L 6011	1.0
G 531 ..	..	..	..	..	..	..	2.0	L 6014	1.0
E 2599 P ..	..	..	..	..	..	..	1.5	L 6068	2.5
A 478 H ..	..	..	..	..	..	..	0.5	R 6152	1.0
E 2668 P ..	..	..	..	..	..	..	1.0	N 6178	1.5
N 3233 ..	..	..	..	..	..	..	0.5	N 6187	2.0
C 164 ..	..	..	..	..	..	..	2.0	K 6197	1.0
NR 538 ..	..	..	..	..	..	..	0.5	M 6199	1.5
D 162 P ..	..	..	..	..	..	..	0.5	—	—
PBS 5311 ..	..	..	..	..	..	..	1.0	—	—
D 168 P ..	..	..	..	..	..	..	1.0	—	—

12 VIRUS DISEASES

Maize streak virus was found to be widespread in the Lower River *dimba* areas, where maize is grown most of the year round. Intensity appears to increase during the winter.

13. TRIAL TO ASSESS LOSS OF YIELD DUE TO LEAF DISEASES

For the fourth consecutive season a trial was conducted to compare the yield of maize open to natural infection with that protected from infection by leaf diseases by means of dithiocarbamate regular spraying with Zineb (zinc ethylene bis dithiocarbamate). The spraying was done twice weekly from when the plants were six weeks old until maturity at the rate of 2 lb. Zineb in 200 gallons of water per acre. This almost completely controlled leaf diseases on the sprayed plots; on the unsprayed plots the infection of *Puccinia sorghi* was generally light and that of *Helminthosporium turcicum* was light to moderate according to the variety. There was a statistically significant general loss in yield of 13.5 per cent. on the diseased plots as compared with the protected plots amounting to the equivalent of 917 lb. of grain per acre. There were differences in susceptibility between the four varieties into which the main treatments were split; the most resistant variety showed the least loss in yield due to the presence of disease, the more susceptible varieties showed a greater percentage and statistically significant loss. The presence of disease affected the maturity of the varieties, the cobs from disease free plots having a higher moisture percentage at harvest than those from diseased plants. The main effect of the disease on yield was to reduce by 9.5 per cent. the average number of cobs per plant, the number of plants from which cobs were harvested was reduced by 5 per cent. and the total number of cobs by 16 per cent.

TABLE V
Trial to assess the effect of Fungus Diseases on Yield of Maize

A. Average Scores per Plant (scale 0.5 to 5.0)						
		N2656 × L5079	Namalenga	Local unselected	Local Hybrid No. 3	
Sprayed Zineb	..	0.1	0.1	0.2	0.2	
Unsprayed	..	1.7	2.3	2.3	2.1	
Sprayed Zineb	..	0.0	0.1	0.0	0.1	
Unsprayed	..	1.0	1.0	1.1	1.0	
B. Yield of grain (lbs. per acre)						
		N2656 × L5079	Namalenga	Local unselected	Local Hybrid No. 3	All varieties
Sprayed Zineb	..	6,881	7,231	5,873	7,137	6,780
Unsprayed	..	6,491	6,074	4,744	6,142	5,863
L.S.D. (P=0.05)	..	—	672	—	—	470
Per cent. decrease	..	5.6	16.0	19.2	13.9	13.5
C. Average number of cobs per plant						
Sprayed	..	1.05	1.26	1.31	1.47	1.27
Unsprayed	..	1.00	1.18	1.15	1.28	1.15
D. Average weight of grain per plant in lb.						
Sprayed Zineb	..	0.51	0.49	0.42	0.53	0.49
Unsprayed	..	0.48	0.46	0.36	0.44	0.43

The figure of 13.5 per cent. general loss compares with 6 per cent., 14 per cent. and 11 per cent. loss in the previous three seasons.

14. COB ROTS

Cob rots caused by species of *Fusarium* and *Diplodia* were prevalent and as infection means total loss of grain serious damage resulted. Counts made on samples of three varieties from the main variety trial at Chitedze are given below.

Variety	Number of cobs examined	Per cent. of infected cobs	Per cent. weight of rotten grain
Local Hybrid No. 2	401	5.5	5.0
Namalenga	407	15.7	14.0
S. Rhodesian Hybrid (N3 × A5) (T4 × M9) ..	443	20.5	26.8

At Toleza, the figures for Namalenga were as follows:

Cobs examined	Per cent. infected cobs
197	17

The cobs observed appeared to be predominantly due to *Fusarium* spp. and *Diplodia*, about equal in intensity, with the remainder, some 10–15 per cent. caused mainly by *Nigrospora oryzae*.

15. MAIZE POUNDING EXPERIMENT

Flint maize is preferred to dent maize by the Africans of Nyasaland not only because of its superior storage qualities but also because they consider that an equivalent quantity of it gives a higher proportion of white flour than does the dent. An experiment was carried out to test this.

Ten women were each given equal samples of flint (Local Hybrid No. 2) medium dent (Namalenga) and heavily dent maize (Southern Rhodesian Hybrid) and from them prepared flour in the traditional way. This process consists of two main steps, first the separation of endosperm (*mphale*) from the other tissues of the seed (*madeya*); the *mphale* is then pounded into white flour (*ufa*) and another small residue (*nsece*) consisting of hard pieces which will not easily break up. The *ufa* is used to make a stiff porridge (*msima*) and the *nsece* a thin porridge (*phala*). The *madeya* is never used for human consumption except in times of famine, but some of it may be eaten by chickens or other livestock. The individual fractions of *mphale*, *madeya*, *ufa* and *nsece* were all weighed and their moisture percentages at weighing determined. Chemical analyses were carried out on bulked samples of the *madeya*, *ufa* and *nsece*.

TABLE VI
Maize Pounding Experiment
Dry weights (gms)
Mean of 10 samples

	A Flint	B Medium Dent	C Dent
Original grain	2,454	2,460	2,445
Madeya	630	695	944
Mphale	1,820	1,770	1,467
Ufa	1,537	1,531	1,227
Nsece	137	93	93

Percentage of fractions

	<i>A</i> <i>Flint</i>	<i>B</i> <i>Medium</i> <i>Dent</i>	<i>C</i> <i>Dent</i>	<i>Least sig.</i> <i>difference</i> (<i>P</i> = 0.05)
<i>Mphale</i> of original	74.2	72.0	60.0	0.5
<i>Madeya</i> of original	25.7	28.3	38.6	0.6
<i>Madeya</i> of <i>mphale</i>	34.6	39.3	64.3	6.1
<i>Ufa</i> of original	62.6	62.2	50.2	0.6
<i>Ufa</i> and <i>Nsece</i> of original	68.2	66.1	54.0	0.5

TABLE VII
Maize Pounding Experiment
Chemical Analysis

	<i>A</i> <i>Flint</i>	<i>B</i> <i>Medium</i> <i>Dent</i>	<i>C</i> <i>Dent</i>
Per cent. Oil	14.12	<i>Madeya</i> 11.89	7.87
" " Protein	11.73	11.21	10.04
" " Fibre	5.83	5.75	5.27
" " Carbohydrate	61.16	67.95	74.34
" " Ash	3.16	3.20	2.48
Per cent. Oil	1.15	<i>Ufa</i> 1.19	0.58
" " Protein	7.19	6.99	5.83
" " Fibre	0.63	0.67	0.68
" " Carbohydrate	90.63	90.55	92.64
" " Ash	0.40	0.60	0.27
Per cent. Oil	0.09	<i>Nsece</i> 0.27	0.22
" " Protein	11.37	10.59	8.87
" " Fibre	0.88	0.82	2.19
" " Carbohydrate	87.19	87.99	88.49
" " Ash	0.47	0.42	0.23

It is seen that there is an appreciable difference in value to the villager between equal weights of flint and dent maize. According to this experiment the flint maize gives 12 per cent. more flour (14 per cent. more usable material when *nsece* is counted) and also the flour is twice as rich in oil and one and a quarter times as rich in protein. The medium dent maize, Namalenga, used in this experiment is much nearer to the flint than to the dent, although it occupies a somewhat intermediate position generally.

It will be noticed that the practice of using *ufa* as opposed to whole-meal flour (*ngaiwa*) results in the throwing away of 37 per cent of the protein and 84 per cent. of the oil in flint maize and 55 per cent. of the protein and 91 per cent. of the oil in dent maize. Food made from *ngaiwa* is not liked because of its taste and is not eaten by most people except in times of famine. Whether a people whose diet is lacking in protein and oil can reasonably afford to discard lightly sources of these foods would seem to be worth further investigation. The increasing of mills in village areas does not affect this question as the people still prepare the *mphale* themselves and take this only to the mill for grinding into *ufa*.

Federal Population and Fertilizer Trials

In conjunction with the Department of Research and Specialist Services, Salisbury, six of these experiments were carried out, but owing to a shortage of the hybrid seed supplied and other factors, populations or harvest were very poor, ranging between 10,000 and 15,000 instead of the planned 12,000 to 17,000 plants per acre. Over the range achieved, the highest population densities increased yields significantly at only two sites, and at only one, Chitala, was this due to the better utilization of applied fertilizer by the dense population. Elsewhere, the population differences were well within the range in which increased number of plants is offset by decreased yield per plant, the actual yield being determined by the nutrient status of the soil.

TABLE VIII

Responses of Maize to Nitrogen, Phosphate, Potash and Population density

Variety: Southern Rhodesian Hybrid. Yields: lb./acre grain

Treatments				Chitedze	Tuchila	Tung Stn.	Chitala	Makanga	Mbawa
N ₀	nil	..	..	4,425	4,810	4,410	1,715	2,370	3,710
N ₁	250 lbs./acre S/A	..	..	5,880***	7,295***	6,040*	4,190	2,445	6,530
N ₂	500 lbs./acre S/A	..	..	6,155***	7,590	6,700	4,715***	2,410	7,400
P ₀	nil	..	..	5,055	6,900	5,410	3,380	2,380	5,575
P ₁	125 lbs./a. Supers.	..	..	5,885***	6,180	5,840	3,495	2,480	6,000
P ₂	250 lbs./a. Supers.	..	..	5,520*	6,615	5,895	3,745	2,365	6,055
S ₀	3' × 14.5"	..	..	5,400	6,160	5,665	3,435	2,375	5,790
S ₁	3' × 12"	..	..	5,725	6,310	5,700	3,250	2,430	5,750
S ₂	3' × 10.25"	..	..	5,335	7,230**	5,790	3,930**	2,430	6,095
Population range in '000				11.1–15.4	10.8–14.9	10.2–11.7	?	?	11.5–14.0
K ₀	nil	..	..	5,585	6,755	—	—	2,580	—
K ₁	50 lbs./acre KC1	..	..	5,385	6,385	—	—	2,240	—
Mean	..	..	..	5,495	6,565	5,715	3,540	2,410	5,880
L.S.D.	..	..	..	405	760	1,125	350	no sig.	1,270
Coef. of Variation	..	..	..	10.9%	17.1%	17.0%	14.5%	10.6%	18.7%

At all sites except Makanga, which has a rather peculiar recent alluvial soil, there were large responses to 250 lb. per acre of sulphate of ammonia (1400–2800 lb. per acre increase), but when the dressing was increased to 500 lb. per acre sulphate of ammonia the additional response was small (300–900 lb. per acre increase) indicating that the optimum dressing is 200–250 lb. per acre sulphate of ammonia.

There was only one significant response to superphosphate and that was at Chitedze where 125 lb. per acre superphosphate gave a larger increase (800 lb. per acre) than a dressing twice the size.

Wherever a comparison was made between blocks with and without 50 lb. per acre muriate of potash, insignificant decreases in yield were obtained.

Residual Khola Manure and Farmyard Manure Trial

Marked responses to organic manures on land in cultivation for many years were obtained in the year of application at Chitedze and Tuchila. Residual effects in the second maize crop were less marked but still appreciable.

TABLE IX
Initial and residual Responses of Maize to Organic Manures

Variety: Namalenga Yields: lb. per acre grain

Treatment	Chitedze				Tuchila			
	Initial		Residual		Initial		Residual	
	Yield	Resp.	Yield	Resp.	Yield	Resp.	Yield	Resp.
F ₁ nil	3,395	—	2,940	—	2,020	—	2,080	—
F ₁ 5 tons/a. F.Y.M. 55/56	3,975	+580*	3,455	+515*	2,235	+215	2,275	+195
F ₂ 10 tons/a. F.Y.M. 55/56	4,095	+700*	3,810	+870*	2,820	+800*	2,450	+370*
K ₀ nil	3,185	—	2,910	—	—	—	—	—
K ₁ 5 tons/acre K.M. 55/56	4,005	+820*	3,450	+540*	not applied		—	—
K ₂ 10 tons/acre K.M. 55/56	4,275	+1,090*	3,845	+935*	—	—	—	—
N ₀ nil	3,365	—	3,480	—	1,745	—	2,100	—
N ₁ 100 lbs./acre S/A 55/56	3,925	+560*	3,405	-75	2,320	+575*	2,465	+365
N ₂ 200 lbs./acre S/A 55/56	4,180	+815*	3,325	-155	3,010	+1,265*	2,240	+140
Mean	3,820	—	3,400	—	2,360	—	2,270	—
L.S.D.	—	280	—	360	—	300	—	260
Coef. of Variation ..	10.8%	—	15.5%	—	18.6%	—	16.8%	—

It is interesting to note that whereas the rather long and bulky F.Y.M. has given equally good responses at Chitedze in both years, it is still not as good weight for weight as the finer and more concentrated *khola* manure, even though the latter gives smaller responses in the second than in the first year.

Khola Bedding Trial

In the 1955/56 season the roofed *khola* at Chitedze was divided in half, and the bedding in one half was mixed with a small quantity of soil when new bedding was added. Thus at the end of the season there was available farmyard manure made with and without the addition of soil. This past season these two manures were applied to the land and tested against various levels of sulphate of ammonia and superphosphate. The farmyard manure made with soil, though it had, as might be expected, a considerable lower percentage analysis of nutrients, gave a greater response than the ordinary F.Y.M., and a five ton-per-acre dressing gave a bigger response than 200 lb. per acre S/A+100 lb. per acre superphosphate, which was roughly its equivalent in inorganic fertilizers.

TABLE X
Responses of Maize to Organic and Inorganic Manures, Chitedze

Variety: Namalenga Yields in lb./acre grain

Treatment	lb./acre of nutrient applied		Yield	Response
	N.	P.		
Control	—	—	2,400	—
100 lb./acre Supers	—	18	2,250	-150
300 lb./acre Supers	—	54	2,445	+45
200 lb./acre S/A	42	—	3,076	+675*
400 lb./acre S/A	84	—	3,130	+730*
200 lb. S/A+100 lb. Supers	42	18	3,240	+840*
400 lb. S/A+300 lb. Supers	84	54	3,690	+1,290*
5 tons/acre F.Y.M. soiled	52	28	3,485	+1,085*
5 tons/acre F.Y.M. without soil	128	81	3,225	+825*
Mean	..	..	2,990	—
L.S.D.	..	..	—	665
Coef. of Variation	..	..	15.3%	—

It is possible that the F.Y.M. made without soil as an inoculant rots more slowly than the other and that much of the nitrogen contained in it is not available to the plant until rotting is complete. A second maize crop this coming season may show this. Another rather unusual feature of this trial is that superphosphate, though it has given no response when applied alone, has boosted responses to nitrogen where both have been applied. Positive N.P. interactions are not common in Nyasaland.

New Mixture Trial (30: 15: 0)

At Chitedze a new compound fertilizer with the composition 30 : 15 : 0 was tested against equivalent mixtures of S/A and superphosphate. The new compound proved to give responses quite as good as an equivalent dressing of mixed fertilizer and was approximately twice as concentrated, but it is very deliquescent, cakes on storage and is difficult to apply. It is considered unsuitable for distribution to African farmers because of its bad handling and storage qualities.

Maize Fertilizer Trials in Agricultural Instructors' Gardens throughout the Territory

Over the past four years simple fertilizer trials have been conducted at sites scattered all over the territory. They are of two types. In the early stages a 2×2 design with two replicates was used, the dressings being nil and 75 lb. per acre sulphate of ammonia and nil and 100 lb. per acre of superphosphate. Later a 3×3 design, with two replications, replaced the earlier pattern, the dressings being 0, 100 and 200 lb. per acre S/A and 0, 150 and 300 lb. per acre superphosphate. 118 experiments in all have been conducted; 45 in the Central Province, 35 in the Northern Province and 38 in the Southern Province. Of these only 36, mostly in Central Province, are of the new 3×3 design which will, it is hoped, enable response curves to be drawn.

TABLE XI
Results of Maize Fertilizer Trials by Districts

Variety: Local

Figures are per cent. of results falling into separate Categories

District	Total No. of trials	Per cent. No. of trials in which responses to 75-100 lb. S/A per acre are:			Per cent. No. of trials in which responses to 75-150 lb. supers per acre are:		
		Economic over 400 lb. acre	Border line 200-400 lb.	Zero under 200 lb.	Economic over 400 lb. acre	Border 200-400 lb.	Zero under 200 lb.
<i>Central Province</i> ..	45	55	27	18	15	20	65
Lilongwe ..	31	61	26	13	22	20	58
Dowa (Plateau) ..	11	46	27	27	0	27	73
Dowa (Lake-shore) ..	3	34	33	33	0	0	100
<i>Northern Province</i> ..	35	57	23	20	23	20	57
Karonga ..	8	38	25	37	0	12	88
Rumpi ..	7	57	14	29	43	14	43
N. Mzimba ..	7	57	43	0	0	14	86
S. Mzimba ..	9	67	22	11	44	33	23
Nkata Bay ..	4	75	25	0	25	25	50
<i>Southern Province</i> ..	38	58	16	26	18	21	61
Fort Johnston ..	11	55	10	35	18	18	64
Blantyre ..	9	90	10	0	0	22	78
Cholo ..	6	66	34	0	50	33	17
Mlanje ..	10	40	10	50	20	20	60
Lower River ..	2	0	50	50	0	0	100

Over the whole territory 55–60 per cent. of all experiments have shown an economic response to 75–100 lb. per acre sulphate of ammonia. Borderline and zero responses may fall into three categories:

- (a) Highly fertile sandy clay loams recently brought under cultivation.
- (b) Badly eroded soils giving very poor control yields, and consequently small total increase, though the percentage increase may be high.
- (c) Certain alluvial soils found on the Lake-shore and Lower River which like those at Makanga are most unresponsive to fertilizers. This last group of soils is found amongst trial sites in Karonga, Dowa Lake-shore, Fort Johnston, Lower River and, it would seem, in Mlanje. They do not respond to superphosphate either and need more study and mapping.

The red loams of the Central Province plateau will in most cases give a useful response to 100 lb. per acre S/A of 2–5 bags per acre grain as will the soils of Blantyre District. Phosphate is of minor importance here.

In Cholo and part of Mlanje District economic responses have been obtained from both 100 lb. per acre S/A (2–5 bags per acre) and 100 lb. per acre supers (2–3 bags per acre) and there has been a significant positive NP interaction, a phenomenon rarely found in Nyasaland soils.

Another district where both nitrogen and phosphate have given good responses (2–4 bags per acre and 2–3 bags per acre respectively) is South Mzimba, with parts of Rumpi District responding likewise.

In North Mzimba unfertilized yields are usually very low and 100 lb. per acre S/A, though only giving a response of 2–2½ bags per acre, may double yields. These sites have not, however, responded to superphosphate.

Though the major demand is for more nitrogen, it is evident that in certain districts the time has already come when phosphate reserves are running low and a compound NP fertilizer is required for African farmers.

Attempts made to correlate responses with soil data obtained in the laboratory have not proved very successful. Percentage responses to nitrogen follow more closely the unfertilized yield of maize than total nitrogen content of the soil. Of the laboratory determinations of phosphate, absorbed phosphate (NH_4F) and alkali soluble phosphate (NaOH) offer some hope of correlation, but field responses to phosphate have been so erratic that it is difficult to find a connection between soil analysis and yield response.

17. CULTIVATION TRIALS

October Preparation of Gardens

This experiment at three stations is in its third consecutive year of maize and the most marked effects are the decreasing yields obtained each successive year. Because of low yields the figures at Tuchila and Mbawa show high errors and no significance. At Chitedze, however, there was a significant increase in yield following the burning of the maize stover as opposed to carrying it off the field.

TABLE XII

Responses of Maize to various Methods of Garden Preparation in October

Variety: *Namalenga*

Yields in lb./acre grain

Treatment						Chitedze	Tuchila	Mbawa
Ridges split	..	..	..	..	..	2,480	1,810	350
Ridges made up	..	..	..	..	..	2,815	1,575	265
Stover burned	..	..	..	..	..	3,085*	1,685	390
Stover buried	..	..	..	..	..	2,770	2,100	400
Stover left as mulch	..	..	..	..	..	2,315	1,595	300
Stover removed (control)	..	..	..	..	..	2,545	1,795	230
Mean	..	..	..	..	..	2,665	1,750	320
L.S.D.	..	..	..	..	..	535	no sign.	no sign.
Coef. of Variation	..	..	..	..	..	13.7%	18.2%	40.4%

Another experiment at Chitedze, comparing methods of garden preparation in October with others earlier in the year, still gives no significant differences, though those containing burning of stover and weeds as a treatment have maintained their lead in this second year of the experiment.

Ridging and Mulching Trial

In the past at Makanga, on the Lower River, methods of cultivation and mulching have given much greater responses than the dressings of artificial fertilizers. This year again there has been no positive response to sulphate of ammonia, superphosphate or muriate of potash, but notable increases due to mulching and some to ridging.

TABLE XIII

Responses of Maize to Ridging and Mulching on Lower River

Variety: *Makanga Selection*. Yields lb./acre grain

Treatment					Yield	Response	Treatment			Yield	Response
Flat	..	..	..	..	2,065	—	No mulch	..	..	1,775	—
Ridged	..	..	..	..	2,245	+180*	Light mulch	..	..	2,045	+270*
Ridged and boxed	..	..	..	..	2,375	+310	Heavy mulch	..	..	2,855	+1,080***
L.S.D. 225 lbs./acre					..	..	Coef. of Variation			15.1%	

Rainfall at 28.43 inches was not very high this last season and as usual in semi-drought years all operations helping to conserve moisture lead to increases in yield.

Extract from Report of Entomologist

Maize Stalk Borer (*Busseola fusca* Hmps) continues to be prevalent in the high-land and higher rainfall areas and in many places wipes out the first plantings. Observations have shown that there are plenty of overwintering diapause pupae in the maize stalks at the end of the dry season. It is hoped to carry out observations by means of light traps in the coming season, and a planting date and insecticide trial is also planned.

OTHER CEREALS

1. FINGER MILLET—ELEUSINE

A trial at Mbawa, to compare burning with no burning and three levels of sulphate of ammonia, showed 200 lb. per acre S/A to give a response about equivalent to that obtained by a burn, both responses being good. The site was a five-year bush fallow previously.

TABLE I
Response by Eleusine to Burning and Nitrogen
Variety: Local. Yields:—bushels unthreshed heads/acre

<i>Treatment</i>	<i>Yield</i>	<i>Response</i>	<i>Treatment</i>	<i>Yield</i>	<i>Response</i>
Not burned	853	—	nil	900	—
Burned	1,445	+590**	100 lbs./a. S/A	1,355	+455**
			200 lbs./a. S/A	1,450	+550**

Coef. of Variation 24.5 per cent.

On other observation plots, an Eleusine crop grown on newly opened fallow land, unburned and unfertilized, was compared with one grown on second-year land after a Turkish tobacco fertilizer trial. Results were:—

1st year land: no burn and no fertilizer 680 lb.
2nd year land: unburned after fertilized Turkish tobacco .. 1,185 lb.

It is suggested that good crops of Eleusine can be obtained without wasting timber in burning by planting on second-year land after a leguminous crop or one receiving liberal fertilizer dressings. It will respond readily to sulphate of ammonia.

2. SORGHUMS

A variety and nitrogen trial at Mbawa showed that with early planting and good cultivation the most suitable varieties, NR/S/6 and U/S 11, can give over 1,200 lb. per acre grain. Much damage was done to some varieties by birds and by head smut. As was the case last year at Chitedze and Mbawa, there was again no response to 100 lb. per acre sulphate of ammonia this year.

3. RICE

Observation plots at Banga in Nkata Bay District were laid out with bunds to control the water. They were planted with seedlings of Faya on 15th December, 1956, at a spacing of 9" × 9" with two plants per hole. Sulphate of ammonia at the rate of 200 lb. per acre was broadcast on 22nd December and the plots were flooded next day. Weed control was excellent, one hand pulling of tall weeds being all that was necessary. The plots which were small, about 1/40th acre, were harvested in mid-May and yielded 4,500 lb. paddy per acre.

A series of observation plots showed that after transplanting pregermination of the seed gave the highest yield and the best control of weeds. The seed was soaked in water for 24 hours and then kept till the radicle was just emerging and broadcast over the wet field. It was found that three ploughings before planting gave higher yields and better weed control than two ploughings.

4. WHEAT

Some observation plots were grown in the Misuku Hills where the soil is acid with a high organic matter content and very high total nitrogen. These showed that nitrogen either in the form of sulphate of ammonia or nitrate of soda depressed the growth and yield of the wheat while superphosphate gave only a slight increase despite the low phosphate status of the soil.

OIL SEEDS

Groundnuts

1. VARIETY TRIALS

At Tuchila and Makanga in the Southern Province this year early bunch varieties have yielded best as is usual, Gambia, a standard early variety, giving about 2,000 lb. per acre shelled nuts on small plots at both places. Late varieties such as Mwitunde and the large nutted runner varieties, such as Chalimbana, yielded but half that amount.

At Chitala, where also early bunch varieties normally do best, two later varieties Mwitunde and Early Runner yielded as well as Gambia, giving 1,500 lb. per acre shelled nuts.

At Mbawa, where late runner varieties have in the past yielded best, Gambia has yielded as well as Mwitunde and the local runner varieties for the first time. Top yields are about 1,000 lb. shelled nuts per acre.

At Chitedze the various types were again well mixed in the order of yield and the range rather less extreme than in other areas (1,000–1,700 lb. per acre). Mwitunde came in the first five with a yield of 1,500 lb. The two large seeded varieties grown, Chalimbana and Sinyala, produced 1,200 lb. per acre shelled nuts.

Chalimbana and Sinyala varieties give about 75 per cent. of nuts at 35 kernels per oz., well within the H.P.S. range. Mbawa Runner, with about 30 per cent. at 37 kernels per oz., and Mwitunde with about 30 per cent. at 40 kernels per oz. are on the border line.

Mwitunde does appear to have one of the highest oil contents of all varieties grown this season, with a mean over all stations of 49.8 per cent. oil on dry kernel weight. High oil content does not appear to be the characteristic of any one type of groundnut but varies considerably from variety to variety. The highest figures obtained this season come from two early bunch varieties, one late bunch and two late runner varieties. The two lowest percentages were returned by one early and one late variety. Environment clearly has some effect as certain stations yield consistently lower oil contents than others. The matter will be dealt with more fully.

The variety Mwitunde was grown by a number of selected farmers throughout Lilongwe District and created a favourable impression. Apparently the tendency of the variety for its nuts to become detached from the haulm and remain in the soil when the crop is lifted much after it has matured, does not worry farmers at this stage, when most lifting and gleaning is done by women and children by hand. It becomes a handicap, however, if mechanization is attempted.

2. EFFECT OF SULPHUR

A residual effect from sulphate of ammonia, applied last year to a sorghum experiment at Mbawa, was most marked this year in the variety trial. Tops were more vigorous and yields higher on those rows which had received the fertilizer, especially where late varieties were applied. The response is suspected to be caused by sulphur and this supposition is to be tested next season.

3. CONTROL OF CERCOSPORA LEAF SPOT

An experiment was conducted at Chitedze to try to control the disease with Perenox spray and sulphur dust and to discover the most economic treatment for the disease. The Perenox was applied at the rate of 1.7 lb. powder per acre per application in about 70 gallons of water, and the sulphur dust applied at the rate of 12 lb. dust per acre per application. Weekly treatments started three weeks after planting and fortnightly ones six weeks after planting.

TABLE I

Effects of Fungicide Treatments on Yield of Groundnuts infected with Cercospora Leaf Spot

Variety: *Mwitunde*
(late maturing)

Cost: Shillings/acre
Yields, etc.: lb. shelled nuts/acre

Treatment	Number of applications	Estimated cost	Yield lb.	Response lb.	Economic return
Control	—	—	1,590	—	—
S. dust weekly at 69s per 100 lb. ..	14	116s-6d	1,975	+385	11s-4d
S. dust fortnightly	6	50s-6d	1,905	+315	54s-0d
Perenox weekly at 286s per 70 lb. ..	14	98s-0d	2,200	+610	105s-0d
Perenox fortnightly	6	41s-0d	1,965	+375	82s-8d

Variety: *A.R.S. "Spanish"*
(early maturing)

Cost: Shillings/acre
Yields etc.: lb. shelled nuts/acre

Treatment	Number of applications	Estimated cost	Yield lb.	Response lb.	Economic return
Control	—	—	1,080	—	—
S. dust weekly at 69s per 100 lb. ..	10	83s-6d	1,415	+335	28s-8d
S. dust fortnightly	4	33s-0d	1,325	+225	48s-4d
Perenox weekly at 286s per 70 lb. ..	10	69s-6d	1,460	+380	56s-4d
Perenox fortnightly	4	28s-6d	1,535	+455	123s-4d

"Costs" are the costs of fungicide only at wholesale prices. At retail prices the Perenox prices would be considerably increased. Economic return is based on a price of 4d per lb. for groundnuts and does not take into account labour. Perenox gives on the whole better control and yield increases than sulphur dust but its economics depend greatly on the price at which it can be obtained. Fortnightly applications are more economic than weekly ones. However, dusting and spraying so easily become uneconomic, unless expertly supervised, that it is not considered worth while advising African farmers to spray against *Cercospora*, though yields can be economically raised in this way, if the work is efficiently carried out.

5. TIME OF WEEDING TRIAL

At Chitedze an early and late maturing variety were planted and the whole area uniformly weeded two weeks after planting. Thereafter plots received one to four weedings evenly spaced between the date of first weeding and the date of lifting.

TABLE II

Effect of Weeds on Groundnut Yields

Varieties:—Mwitunde, A.R.S. "Spanish"

Yields: lb/acre shelled nuts

Treatment	Mwitunde		A.R.S. Spanish	
	Yield	Response	Yield	Response
Weeded 17/12/56 +1	735	—	600	—
" " " " +2	1,035	+300	770	+170
" " " " +3	1,115	+380*	955	+355*
" " " " +4	1,320	+585**	970	+370*
Mean	1,050	—	825	—
L.S.D.	—	275	—	275
Coef. of Variation 13.0 per cent.	13.0%	—	16.6%	—

Weed competition affects yields considerably even at a late stage of the plant's development, and can reduce yields by as much as a third.

6. MISCELLANEOUS

Bulk plots at Chitedze gave 1,500 lb. per acre Mwitunde and 1,000 lb. per acre A.R.S. Spanish. Labourers were able to shell 13.0 lb. of Spanish and 12.0 lb. Mwitunde per man per day.

Extract from Report of Agricultural Chemist, Bvumbwe

Studies on the oil content of groundnuts and the factors affecting it were continued. Of the various samples taken from markets, only one had an oil content of less than 45 per cent., sixteen contained 47–50 per cent. oil, and nine contained more than 50 per cent. oil, all figures being on a dry weight basis.

1. EFFECT OF SIZE

The effect of general quality on oil content was examined by hand grading. The need for grading is seen by data on selected good seed taken from several market samples:—

Oil content (Dry kernel)				Chikweo	Lingoni	Mtwiche	Nselema	Ntaja	Songani
As received	..	..	..	49.7	52.9	48.5	45.1	48.9	50.6
Selected good seed	..	..	..	51.2	56.2	50.8	48.6	50.2	53.4

In addition to this increase of 1–3 per cent. obtained by omitting immature and shrivelled seed, the oil content of sound seed also seems to vary; the proportion of seed of size giving less than 50/60 per oz. being 91 per cent. in both the following samples.

				Per cent. oil in sound seed of size		Bulk samples	
				Less than 50/60 oz.	More than 50/60 oz.	Theor. oil content	Determined content
Ntaja	..	..	..	50.1	40.3	49.1	49.3
Nyambi	..	..	..	49.6	42.2	48.8	47.4

This is in accordance with observations elsewhere that the yield of oil is a function of the proportion of plump kernels—and that conditions producing a high shelling

percentage also give a rather higher oil content. Maturity is most important, for only a week before full maturity, the oil content is appreciably less than the maximum possible.

To examine further the importance of size, etc., a representative sample of export seed was taken and graded into six sizes according to number per oz. Each grade was then put through the 15/64" sieve, the proportions retained being shown below. The oil contents were determined, and are also given.

TABLE III
Effect of Seed size on Oil Content of Kernel

Group	No. per oz.	per cent. of this size in bulk	Per cent. of this group retained on		Per cent. oil on dry seed
			21/64"	15/64"	
I	27	9	81	19	47.6
II	40	22	56	44	47.1
III	55	35	15	85	46.0
IV	66	24	0	95	42.4
V	80	8	0	80	39.8
VI	94-124	2	0	0	34.2

Calculation shows that the 21/64" sieve would retain 25 per cent. of the bulk, the 15/64" seive a further 70 per cent; only 5 per cent. going through this sieve. The 5 per cent. passing the 15/64" sieve would contain 34-35 per cent. oil. The average oil content of the bulk sample was 44.7 per cent.

Thus the difference between laboratory and trade samples is explained; and is further stressed by the following figures obtained on representative samples taken from exports to three main purchasers this season.

	Buyer		
	A	B	C
Per cent. oil in dry kernel	44.4	45.6	45.2
Per cent. oil—allowing 3.5% testa+6% moisture	40.3	41.3	40.0

2. THE EFFECT OF VARIETY

Although Nyasaland nuts are very mixed, the oil content of several varieties was determined, the figures being as follows: (Corresponding figures obtained on the 1953-54 crop being quoted for comparison.)

	Mwitunde	Gambia	Spanish bunch
1955-56	46.4	45.3	47.7
1953-54	44.9	—	50.0

Mwitunde and Gambia are also lower in oil content than Natal Common (49.7 per cent.) and Chimwila (49.1 per cent.), these latter figures also being obtained in 1954.

The above data would seem to indicate that Nyasaland nuts are not inherently low in oil content and are generally similar to East African nuts. It does, however, appear that the oil content may vary appreciably according to the size of seed, and the proportion of large nuts that any sample contains. It also appears that the Southern

Province seed may contain rather more oil (49 per cent.) than found in Central and Northern Province nuts (46–48 per cent.). Whether this difference is associated with rainfall or temperature is at present being investigated. In this connection, it may be noted that, generally, West Africa and Madagascar nuts have a higher oil content than those from East Africa.

As it had been commented that Nyasaland nuts contained less oil than those of Southern Rhodesia, a sample of the latter nuts were also examined. The sample was very mixed, and separation of the seed was made by size and varieties as shown:—

TABLE IV

	<i>Per cent. of seed of this type</i>	<i>Per cent. moisture content of kernel</i>	<i>Per cent. oil content of dry kernel</i>
Bulk sample	—	6.0	51.1
Size I 21/64" or more ..	12	6.2	52.8
„ II 15/64"–21/64" ..	81	6.4	51.1
„ III 15/64" or less ..	7	7.2	47.8
Pink varieties	13	7.2	50.9
Longnuts	27	7.5	52.7
Round nuts (brown) ..	30	7.2	54.1
Medium nuts (light brown) ..	30	5.9	52.2

The oil content of the seed allowing for 3.5 per cent. testa and 6 per cent. moisture is 46.5 per cent. and though this figure confirms the rather higher oil content of Southern Rhodesian nuts, the difference between Nyasaland nuts would not appear as high as originally supposed. The decrease in oil content with size is also noted—but the lowest figures compare favourably with the general figures for Nyasaland nuts.

Closer grading by size was also made by hand picking, the figures being as follows:—

No. per oz.	30	40	40–50	60	70	90–100	140
Per cent of bulk	20	17	15	14	14	13	7

Samples of the varieties sorted are being grown to see if the oil content will be maintained in this country.

A sample of nuts from Northern Rhodesia was also examined, and found to contain 46.4 per cent. oil on a dry weight basis, and thus show little difference from Nyasaland nuts. This particular sample contained approximately 10 per cent. mouldy seed, giving an oil of 15 per cent. free acidity. This caused the oil extracted from the bulk to be rather higher in acid content at 1.0–1.5 per cent.

SAMPLING

In view of the variation in oil content found between small and large nuts, the possibility of this affecting sampling for oil content was examined, as it had been noted that slightly different figures for oil content of the same seed had been obtained at the Chitedze and Bvumbwe laboratories. Four different small lots were therefore taken from bulk a sample of Gambia seed. Each was milled, and duplicate determinations were made on the resultant meal, two of the samples being ground with sand after two and four hours, and the others after four hours only. The duplicate results agreed, but the differences due to sampling can be seen in the following table, the four figures under A and B varying between 42.8 and 45.3 per cent.

						A	B	C
Grinding after	2 and 4 hours extraction	..	..	..	..	45.3	42.8	44.8
"	" 4 hours only	..	..	..	..	44.1	43.5	44.4

A further selection, C, from the same sample, was ground, and then two portions of this meal examined by the alternative extraction producers. The duplicates again agreed, and the two different extraction methods gave more comparable figures when the same meal was used. It therefore appears that an appreciable sample of seed should be milled, and the resultant meal used for the determination of oil content.

Extract from Report of Agricultural Chemist, Chitedze

(a) In order to find the type of nut best suited to the local conditions prevailing in different areas of Nyasaland, preliminary examinations for oil content were undertaken on several identical varieties grown at research stations throughout the Territory. A selection of the results are set out in Table V.

TABLE V
Analysis of Groundnut Varieties
(Mean per cent. oil at 6 per cent. moisture)

Variety	Mbawa	Chitala	Chitedze	Tuchila	Makanga
Chimbuwila	43.9	45.2	43.4	41.8	44.3
Gambia	45.6	44.8	43.7	42.7	46.0
Mbawa	43.6	42.8	40.7	41.4	43.3
Mwitunde	45.6	46.3	46.0	43.4	46.3
Early runner	43.8	45.7	42.8	43.8	—
SA/A 6	44.3	46.0	44.2	42.7	—
U/A 19	43.7	43.6	42.1	43.4	—

(b) Forty-one samples submitted for moisture determinations by the A.P.M.B. prior to the opening of their markets in the Central Province, showed an average moisture content of 6.3 per cent. with the exception of certain markets in the Dedza area and one in Kasungu. This was a marked improvement over the previous season when moisture contents were considerably higher due to the late rains.

Extract from Plant Pathologist's Report

In the course of a survey of the incidence of *Cercospora personata* (B & C) El. et Ev. and *C. arachidicola* Hari, it was found that at Chitedze the epidemic was due entirely to *C. arachidicola*. In the lower lying areas, represented by Makanga (Lower River) and Tuchila (Palombe Plain) stations, *C. arachidicola* appeared first but *C. personata*, appearing later, spread much more rapidly and assumed epidemic proportions before the nuts were harvested. It is thought that Chitala (Lake-shore) station would give the same picture as the latter two, but the supply of specimens from this station stopped halfway through the season. On all the stations the disease was first noticed 45–50 days after planting.

At Mbawa (Northern Province) *C. arachidicola* was present the whole time, and though *C. personata* built up towards the end of the season, it did not assume epidemic proportions.

Groundnut rosette incidence was generally low, although this disease is widespread.

Investigations into the cause of "pops", mentioned in the last Report, have not proceeded any further.

Castor Oil

Plots of castor sown in Karonga District grew moderately well. Inflorescence blight continues to attack any castor plants grown at Chitedze.

Seed of wild sesamum was collected at Chitedze for trial next season. Plots of sesamum sown early, i.e. February, did very well at Baka and Lupembe, yielding better when planted 18"×18" than when broadcast. 500 lb. seed per acre may be expected.

Soya

No experiments were planted at Byumbwe this year but one acre each of the six best varieties were planted for seed bulking. The mean yields over the last three years are as follows:—

	<i>lb./acre</i>
S. 100	2,288
Volstate	2,229
Hernon 279	2,227
Pelican	2,190
Peruvian Yellow	2,062

Of these S.100 is prone to shattering and harvesting is therefore difficult. It is otherwise very similar to Volstate. Volstate has been chosen for growing on the mixed farm; it is very upright and early maturing, having finished flowering by 1st March and ready for harvest about six to seven weeks later. Hernon 279 has a similar habit and matures a day or so later than Volstate. Pelican is upright and bushy in habit and ceases growth before Hernon. It is very similar to local yellow which may be synonymous. It matures about a week before Volstate and therefore might be a useful variety to grow with it where there is a large acreage to harvest. Peruvian Yellow is similar in general appearance and habit to Benares but not so vigorous. Benares is a low yielder but has been chosen as a green-manure variety since it is a very vigorous grower with large leaves. It can also be used as a green fodder crop or in silage. The stems become prostrate; if grown for seed it will take longer to mature (six to seven weeks after Volstate) and the seed is small. Yield is also lower, the three year average being 1,484 lb./acre.

OTHER LEGUMES

Ground beans (*Voandzeia Subterranea*)

At Chitedze, the best varieties of these obtained from Northern Rhodesia and Mbawa produced 550–700 lb. per acre shelled seed. Putting earth on top of the plants after flowering again made little difference at Chitedze, though at Banga, Nkata Bay, last year earthing-up increased mean yields from 600 to 800 lb. per acre. It pays to plant this crop reasonably early—before the middle of January at any rate.

Soya Beans

At Makanga, on the Lower Shire, yields of about 2,000 lb. per acre were obtained and superphosphate was found to decrease yields. At Magomero, observation plots of seven varieties gave over 1,500 lb. per acre seed, the best being B.C.A. Yellow, Volstate and Light Speckled.

In the Northern Province, Potchefstroom seems to be about the best variety. It gave 1,400 lb. per acre at Katowo and 650 lb. per acre at Ng'onga in Rumpi District. Inoculation did not increase yields very much this year, though last year on the same plots the effect was marked. Early planting increases yields, but the crop can be sown as late as Christmas time in the north without losing too much in the way of yield.

At Chitedze a poorly-grown bulk of soya beans yielded 600 lb. per acre.

Sundry Legume observations

Sunn hemp grown for seed at Chitedze suffered badly from stem break and yielded but 100 lb. seed per acre. Sunn hemp planted in Karonga at Baka and Lupembe did very well, yields of 1,000–1,500 lb./acre being obtained.

Bulk beans at Chitedze produced good ground cover but only 200 lb. per acre of beans.

At Karonga black gram out-yielded green gram, yields of 1,200 lb./acre of black gram being obtained under the best conditions as compared with 700 lb./acre of green gram.

Small observation plots of upright cowpea (*Vigna sinensis*) and Jack Bean (*Canavalia ensiformis*) were planted at Bvumbwe in January.

The cowpeas were harvested late April to early May, Dr. Saunders maturing earlier. They gave the following yields of clean seed:—

Dr. Saunders	..	..	..	..	..	471 lb./acre
Mung	..	..	..	..	..	242 lb./acre

The Jack Bean grew well but many of the pods were covered in lesions (probably caused by the heavy rain in April); the only fungus consistently associated with them was the saprophyte *Acremonium*. Yield of clean seed was 298 lb./acre. It is intended to try the Jack Bean again at Bvumbwe with an earlier sowing; it would fit in well with the rotation of mixed farm and is a good source of protein.

Extract from Plant Pathologist's Report

SUNN HEMP

Stem break, caused by *Colletotrichum curvatum* (Biyant & Martin), occurs commonly in sunn hemp grown in Nyasaland, and was widespread, though not very severe during the year under review.

A new disease found on sunn hemp during the year is due to a species of *Fusarium*, causing a wilt. This wilt is similar to the wilt described by Hean in South Africa. As the disease appeared suddenly in an area in which sunn hemp had not before been grown, it was thought that the disease might be seed-borne. A fungus similar in culture to the causal fungus isolated from disease tissues has been obtained from unsterilized seed, planted out on potato dextrose agar, but not from seed sterilized in mercuric chloride sol. in experiments to test the pathogenicity of this fungus are being made.

ROOT CROPS

Sweet Potatoes

Experiments testing time of planting and lifting of four varieties in 1956 and 1957 showed that there may be a marked decrease in yield of tubers if cuttings are planted later than the end of January. Lifting the tubers at monthly intervals from 6th July to 6th September had much less effect than date of planting. The highest yielders, Mkokabwato and Malamulo, were also those most adversely affected by late planting and seemed to have a period of peak yield 160–170 days from planting, in the case of the former, and 200–210 days from planting in the case of the latter. The 1957 experiment had to be discontinued after the first lifting on 6th July, but its results are different enough from those of the previous year to warrant further repetition of this trial in years to come.

TABLE I
Effects of Time of Planting and lifting on Sweet Potato Yields

Variety: Various Yields: Short tons/acre

Date planted 1957					Yield	Date planted 1956		Yield	Date harvested 1956		Yield
15/1/57	..	..	..	..	5.01	9/1/56	14.78	6/7/56	10.99		
2/2/57	..	..	..	..	5.57	30/1/56	11.99	7/8/56	10.80		
16/2/57	..	..	..	..	4.27	18/2/56	4.97	6/9/56	9.95		

Variety					1956 Wt/root lb.	Yield (mean July–Sept.)	1957 Wt/root lb.	Yield (July only)
Malamulo	...	..	..	..	.56	11.62	.39	4.68
Mkokabwato	..	..	..	..	.52	13.99	.46	6.70
Kamciputu	..	..	..	..	.37	7.07	.30	5.05
Kacamba	..	..	..	..	.38	9.64	.29	3.38

Cassava

(a) VARIETY TRIALS

At Chitedze the most promising of the mosaic resistant Amani varieties are T₃, T₅, T₁₁, T₁₄, T₁₈ and T₁₉. These show marked resistance to mosaic, except T₁₄ and T₅ which are only moderately resistant, and produce reasonable flour and edible raw roots.

At Kota Kota T₅, T₁₁, T₁₄, T₁₈ and T₁₉ all produce fair yields at 13 months age, but all except T₁₄ and T₁₈ are rejected on eating qualities. T₁₄ is not very mosaic resistant and T₁₈ is not a very high yielder though very popular for its flavour. Some more recent Amani introductions have in 13 months produced three or four times the yield of the old ones. These are Msitu, 49139/1 and 4705A/31, which have also shown promise at Tuchila. Best yielders at Chitedze, amongst the local varieties, are Kawalika, Somaliland, Bitisumani, Kwete, Kadango, Chimphuno, Usufu and Kanjuci.

(a) TIME AND METHOD OF PLANTING TRIAL

An experiment at Chitedze on time of planting and lifting of cassava, with two sizes of cutting, showed that it pays to plant early, provided that no drought is to be expected in January. Yield per plant, and hence potential yield per acre, decreased

from 8.1 lb. from the mid-December planting to 3.7 lb. from the mid-February planting. There was, however, a dry spell in January, 1955, so the stand and actual yield per acre was lowest from the early January planting. Early planted plants, once established, looked larger and healthier right through the experiment. If planted when the rains are reliable, the size of cutting makes little difference, but where drought is likely shortly after planting the larger cuttings are better, 12 inch ones giving a better stand than 6 inch ones. Cutting size does not affect the yield per plant. Cuttings should be planted vertically with only the top two nodes above ground. Yield per plant increased from 4.3 lb. at 18 months to 6.2 lb. at 30 months, but as loss through drought, pest and frost reduced the percentage of plants harvested from 67.5 at 18 months to 37.5 at 30 months the actual yield per acre obtained at the later harvest was less than at the earlier one.

TABLE II
Effect of Time of Planting and Lifting and Cutting size on Cassava yields

Variety: Maonga, Kolosiko

Yields: Short tons/acre

<i>Treatments</i>				<i>Per cent. take</i>	<i>Per cent. plants harvested</i>	<i>Wt/ root lb.</i>	<i>Wt/ plant lb.</i>	<i>Theor. Yield</i>	<i>Actual Yield</i>
<i>Planted</i>									
Mid-December	..	..	..	95.0	70.0	1.4	8.1	14.7	9.7
Early January	..	..	..	66.2	37.5	1.1	5.4	9.8	3.2
Late January	..	..	..	70.6	52.5	.9	4.0	7.3	3.7
Mid-February	..	..	..	74.5	47.5	.7	3.7	6.7	2.9
<i>Cutting size</i>									
6" cuttings	..	..	..	68.9	47.5	1.0	5.0	9.1	4.5
12" cuttings	..	..	..	84.4	57.5	1.0	5.5	10.0	5.2
<i>Lifted</i>									
18 months	..	..	..	(77.2)	67.5	.7	4.3	7.8	5.2
30 months	..	..	..	(76.1)	37.5	1.3	6.2	11.2	4.6
MEAN	..	..	..	76.6	52.5	1.0	5.2	9.5	4.9

Extract from Plant Pathologist's Report

EUROPEAN POTATOES

With heavy continuous rain in the early part of the season, potatoes suffered defoliation by heavy attacks of early blight, *Alternaria solani* (Ell. & Mart.) Sorauer. It is thought that one or two unconfirmed reports of late blight, caused by *Phytophthora infectans* (Mont) de Bary, were the result of confusion with early blight.

A small investigation into winter potato production in *dimba* gardens has revealed a very high incidence of infection by *Pseudomonas solanacearum* (EFS) Dowson causing Bacterial wilt. The incidence of this disease is so high, in fact, that the local people of the area have been forced into a rudimentary form of rotation, as they have noticed the impossibility of growing two crops in succession on the same land.

TOBACCO

Dark Fire-Cured Tobacco

1. VARIETY TRIAL

Twelve varieties—local strains and selections as well as imported types—were again examined to discover if there were significant differences among them in yield and quality. The selection from Lingadzi Estate gave the highest yield per acre but, like the American Madole, it lacked the quality (Grade Index) possessed by the Agricultural Research Station 51 strain.

TABLE I
Dark Tobacco—Variety Trial

Variety				Yield (lbs/ acre)	Grade Index	Crop Index
Western: Lingadzi	..	..	..	623	47.03	29,278
Madole	..	..	..	616	45.91	28,289
A.R.S. 51	..	..	..	504	53.23	26,828
C3/42/AA	..	..	..	535	50.15	26,828
Little Crittenden	..	..	..	511	50.72	25,895
Type 5	..	..	..	508	49.89	25,351
C1/14/A	..	..	..	506	49.73	25,169
Western: Roma	..	..	..	572	42.36	24,236
Greenwood	..	..	..	499	48.53	23,214
A.R.S. 53	..	..	..	487	48.33	23,511
Brownleaf	..	..	..	456	48.36	22,053
A.R.S. 56	..	..	..	442	48.72	21,554
L.S.D. (P=0.05)	..	..	..	67	4.14	—

Coupled with this a fertilizer trial showed the significant increase in yield which could be obtained by applying nitrogenous fertilizer. There was no fertilizer-variety interaction.

TABLE II
Dark Tobacco—Fertilizer Trial

Fertilizer				Yield (lbs/ acre)	Grade Index	Crop Index
Nil	..	..	..	358	47.69	17,064
200 lb. per acre superphosphate	..	..	..	382	45.68	17,431
200 lb. per acre sulphate of ammonia	..	..	..	575	50.85	29,223
200 lb. per acre sulphate of ammonia	..	..	..	772	50.10	38,679
200 lb. per acre superphosphate	..	..	..	36	14.42	—
L.S.D. (P=0.05)	..	..	..	36	14.42	—

2. FERTILIZER TRIALS

(i) 30:15:0 Mixture

The results from the use of this mixture both at Chitedze and Nsaru were similar to those with maize. No difference in yield or quality were apparent between the different amounts of the mixture and comparable dressings of sulphate of ammonia.

TABLE III
Dark Tobacco—30:15:0 Fertilizer Trial—Nsaru

<i>Fertilizer</i> (lb. per acre)	<i>Yield</i> (lb./acre)	<i>Grade</i> <i>Index</i>	<i>Crop</i> <i>Index</i>
150 lb. 30:15:0	727	51.74	37,600
100 lb. 30:15:0	660	49.46	32,642
75 lb. 30:15:0	582	47.16	27,438
150 lb. sulphate of ammonia	645	48.70	31,408
100 lb. sulphate of ammonia	623	47.85	29,817
Nil	248	41.60	10,334
L.S.D. (P=0.05)	141	4.04	—

(ii) *Responses to Nitrogen and Phosphate*

A series of trials to determine the nitrogen and phosphate requirements of various soil types found near Chitedze were conducted with co-operation of estate owners.

Response to nitrogen was found on all soils—a dressing of 150 lb. per acre sulphate of ammonia gave increased yield and improved the quality of the leaf. Where nitrogen status was really low 300 lb. sulphate of ammonia gave a further increase in yield.

Quite unlike previous work a significant increase in the weight and quality of the leaf per acre was found in some cases when dressings of 250 lb. superphosphate were given per acre. Further increase was not apparent when the fertilizer was applied at 500 lb. per acre.

TABLE IV
Dark Tobacco—Fertilizer Trials
(a) NAMITETE ESTATE

<i>Fertilizer</i>	<i>Site 1</i>		<i>Site 2</i>	
	<i>Yield</i> (lb./acre)	<i>Grade</i> <i>Index</i>	<i>Yield</i> (lb./acre)	<i>Grade</i> <i>Index</i>
(i) <i>Sulphate of Ammonia lb. per acre</i>				
Nil	505	35.14	331	35.88
150	707	43.07	599	42.87
300	810	44.76	732	47.81
(ii) <i>Superphosphate lb. per acre</i>				
Nil	481	33.67	453	41.82
250	747	43.74	639	43.33
500	793	45.56	569	41.40
L.S.D. (P=0.05)	136	5.55	158	4.12

(b) LINGADZI ESTATE

<i>Fertilizer</i>	<i>Site 1</i>		<i>Site 2</i>	
	<i>Yield</i> (lb./acre)	<i>Grade</i> <i>Index</i>	<i>Yield</i> (lb./acre)	<i>Grade</i> <i>Index</i>
(i) <i>Sulphate of Ammonia lb. per acre</i>				
Nil	484	44.52	523	44.40
150	793	46.64	791	56.29
300	925	50.98	976	57.77
(ii) <i>Superphosphate lb. per acre</i>				
Nil	748	48.65	467	47.49
250	762	47.62	564	50.77
500	692	45.87	659	47.93
L.S.D. (P=0.05)	212	8.20	114	4.95

(c) Agricultural Research Station

<i>Fertilizer</i>	<i>Yield (lbs per acre)</i>	<i>Grade Index</i>
(i) <i>Sulphate of Ammonia (lbs per acre)</i>		
Nil	355	40.40
150	545	51.10
300	692	54.70
(ii) <i>Superphosphate (lbs per acre)</i>		
Nil	469	47.49
250	564	50.77
500	559	47.93
L.S.D. (P=0.05)	114	4.95

(iii) *Responses to Phosphate and Potash*

At Tuchila Experiment Station heavy dressings of superphosphate (300 lb. and 600 lb. per acre) gave no increase in either yield or grade index. A slight significant response in yield was, however, obtained when 75 lb. of muriate of potash were applied per acre.

TABLE V
Dark Tobacco—Fertilizer Trial
TUCHILA EXPERIMENT STATION

<i>Fertilizer</i>	<i>Yield (lb./acre)</i>	<i>Grade Index</i>
(i) <i>Phosphate</i>		
Nil	1033	46.23
300 lb. per acre superphosphate	980	44.75
600 lb. per acre superphosphate	980	42.55
(ii) <i>Potash</i>		
Nil	916	45.55
75 lb. per acre muriate of potash	1029	45.08
150 lb. per acre muriate of potash	1049	42.09
L.S.D. (P=0.05)	98	7.64

3. LEAF SIZE

Attention has been focussed on the question of the possibility that the "Western" leaf has been steadily becoming narrower as the years progress.

Records only show that in 1931 the range of the leaf length-width ratio was from 2.1 to 2.9. A comprehensive series of leaf measurements on the bulk crop at Chitedze led to the selection of plants whose middle leaf had an average length-width ratio of 2.5 or less as foundation stock for next year's seed crop.

In the variety trial there were no differences in respect of the leaf length-width ratio between varieties; neither had fertilizer an effect on leaf size.

Heavy wrapper leaf of medium length (19-23 inch) from Lingadzi Estate was distinctly broader than leaf of similar grade from Chitedze and surrounding trust land.

TABLE VI
Dark Tobacco—Leaf Size

Source				Average length (ins.)	Average width (ins.)	Average length- width ratio
Lingadzi Estate	..	..	..	22.6	8.10	2.81
Chitedze	..	..	..	22.2	7.20	3.12
Trust Land	..	..	..	22.7	6.80	3.40

Burley Tobacco

1. VARIETY TRIAL

Comparing five "foreign" types of Burley with the locally grown "Stand Upright" showed that the Nyasaland Burley has as high a yield per acre as the imported types. Kentucky 16 was the only variety poorer in quality (Grade Index) than the rest.

The market demand at present is for a "coloury" (light cinnamon) leaf. In this experiment it was shown that little variation existed in "coloury" proportions among varieties: external factors such as climate, soil and cultural techniques may have the greatest effect of all on the production of "coloury" leaf.

TABLE VII
Burley Tobacco—Variety Trial

Variety				Yield (lb./ acre)	Grade Index	Crop Index	Percentage "Coloury"
Stand Upright	..	..	..	1,417	65.28	92,511	61.6
Barnet Special	..	..	..	1,355	60.34	81,786	58.4
Kentucky	..	..	..	1,259	59.02	74,319	56.7
Gay's Yellow	..	..	..	1,149	64.61	74,204	66.8
Green Briar	..	..	..	1,150	63.85	73,446	67.0
Kentucky 16	..	..	..	1,276	55.52	70,864	54.2
L.S.D. (P=0.05)	..	..	..	348	8.42	—	—

2. FERTILIZER TRIALS

(i) Responses to Nitrogen and Phosphate

Similar to those with dark-fired tobacco a range of experiments was conducted on on nearby estates.

Quality and yield were significantly increased in every case by applying 150 lb. per acre sulphate of ammonia. The slight improvement in yield from increasing this dressing to 300 lb. per acre, while not significant, could be justified at present day prices.

Phosphate response was found only a distinctly phosphate deficient soil. 250 lb. per acre superphosphate was adequate to ensure a significant increase in yield and quality.

The percentage "coloury" leaf in one experiment decreased from 56 per cent. to 47 per cent. when the nitrogen application was increased from 30 to 60 lb. per acre. Increased phosphate also led to decreased "coloury" proportions.

TABLE VIII
Burley Tobacco. Fertilizer Trials
(a) KAKUYU ESTATE

Fertilizer	Site 1 Variety: <i>Stand upright</i>			Site 2 Variety: <i>Barnet special</i>		
	Yield (lbs./acre)	Grade Index	Percentage "coloury"	Yield (lbs./acre)	Grade Index	Percentage "coloury"
(i) <i>Sulphate of Ammonia</i> lbs. per acre						
0	423	52.33	42.17	1,091	58.37	56.68
150	612	58.22	37.36	1,541	64.16	50.93
300	734	67.17	39.02	1,739	65.07	47.95
(ii) <i>Superphosphate</i> lbs. per acre						
0	495	53.36	36.56	1,424	63.16	54.37
250	669	60.68	39.51	1,486	63.15	51.63
500	606	63.69	42.49	1,460	61.30	49.56
L.S.D. (P=0.05)	145	5.06	9.21	169	4.65	8.29

(b) KILLYNURE ESTATE

Variety: Kelly						
Fertilizer				Yield (lbs./acre)	Grade Index	Percentage "coloury"
Sulphate of Ammonia lbs. per acre						
0	..	..	..	755	42.32	36.72
150	..	..	..	963	46.31	36.04
300	..	..	..	1,063	49.04	38.19
Superphosphate lbs. per acre						
0	..	..	..	397	43.94	35.29
250	..	..	..	973	47.80	39.09
500	..	..	..	910	45.94	36.58
L.S.D. (P=0.05)	..	..	..	310	6.43	10.29

(c) AGRICULTURAL RESEARCH STATION

Variety: <i>Stand upright</i>						
Fertilizer				Yield (lbs./acre)	Grade Index	Percentage "coloury"
(i) <i>Sulphate of Ammonia</i>						
<i>lbs. per acre</i>						
0	..	..	..	675	46.55	53.34
150	..	..	..	951	57.71	59.36
300	..	..	..	1,143	64.11	58.14
(ii) <i>Superphosphate</i>						
<i>lbs. per acre</i>						
0	..	..	..	885	54.07	61.07
250	..	..	..	962	57.03	54.31
500	..	..	..	922	57.23	55.43
L.S.D. (P=0.05)	..	..	..	105	5.93	6.81

Extract from Plant Pathologist's Report

TOBACCO—FLUE-CURED

The 1956/57 season was characterized by heavy rains in most parts of the country. This provided ideal conditions for many fungal parasites. *Alternaria longipes* (Ell. et Ev.) Mason was again widespread, but not serious, except in one or two localized instances where there was unbalanced PK/N ratio, producing symptoms of potash deficiency. *Cercospora nicotianae* (Ell. et Ev.) was also widespread, but nowhere assumed epidemic proportions. The conidial stage of *Erysiphe cichoracearum* DC was more common this season than in previous seasons. Mosaic was present in all areas, mosaic spotting and mosaic scorch being very common symptom expressions of this disease.

One physiological condition of flue-cured tobacco which was particularly common was sunscorch.

The start of the 1957/58 tobacco season has been rather marred by the advent of Anthracnose *Colletotrichum tabacum* (Böning) a first official record for this country. This disease, first seen in the Magomero area, has since broken out in five other sites. All the farmers who have had outbreaks of the disease used seed from the same source, which creates a grave suspicion that, contrary to Rhodesian experience, the disease was, in this case, seed-borne, particularly as no other farmers have reported outbreaks of the disease. Samples of the suspect seed have been sent to the Government Seed Analyst in Salisbury for examination. It is hoped that the outbreaks so far reported are successfully under control: it is essential to prevent its spread to African trust land nurseries of fire-cured tobacco, where it would be impossible to control.

BURLEY

Following particularly heavy storms in the Lilongwe District, a few scattered outbreaks of Wildfire, due to *Pseudomonas tabacum* (Wolf and Foster), occurred. Further spread of the disease was prevented by the advent of drier weather.

Mosaic and leaf curl viruses were reported widespread in the Lilongwe District.

DARK FIRED

A heavy attack of *Alternaria longipes* (Ell. et Ev.) Mason developed on dark-fired tobacco in one area. This was thought due to the use of sulphate of ammonia alone as fertilizer, rather than the use of a balanced fertilizer.

TURKISH

Turkish tobacco culture, in its infancy in the Northern Province, encountered many diseases. *Septomyxa affinis* (Sherb) Wallr, the fungus causing scab, spread on seedlings into the field, where further development was aided by the close spacing involved in Turkish tobacco culture. *Alternaria longipes* (Ell. et Ev.) Mason caused considerable loss at one locality, and both *Cercospora nicotianae* (Ell. et Ev.) and the conidial stage of *Erysiphe cichoracearum* DC were present.

COTTON

REPORT OF COTTON SPECIALIST (E.C.G.C.)

Cotton Breeding

CLB, CL. 20, AND ALBAR 51

The main objective of this season's work was to decide the successor to CLB (Crown Land Bulk), which has been the commercial cotton of Nyasaland since 1933. A longer and finer quality of cotton can be grown successfully, as was shown by the spinning tests on CL.20 given in previous Reports; and the U.4 components of CLB had a staple length of $1\frac{1}{8}$ " (E.C.G.C. Progress Reports, 1938/39 p. 142).

Last year's decision, to introduce CL. 20 in the Central and Southern Provinces, was to be reviewed in the light of experience this season, and a final decision taken on the best Albar selection for eventual distribution. The trial programme was planned to give the maximum possible information on which to decide these two points.

CLB, CL. 20, and the best three Albar 51 strains were planted in replicated yield trials at Makanga and Ngabu in the Lower River; at Toleza in the Upper Shire Valley; and at Chitala in the Central Province. In addition, 147 trials, each consisting of a single replication, were planted in African cotton gardens throughout the cotton-growing districts. (The district staff of the Department of Agriculture were most helpful in the carrying out of these trials.) Seed cotton from all the trials (except Chitala) was brought to Makanga for weighing.

The trial at Ngabu had to be refilled extensively, and suffered badly from surface wash in December and January. At Chitala, red bollworm attack resulted in very low and irregular yields; the district trials in the Salima area, round Chitala, were attacked even more severely. Four of the district plots in the Lower River were abandoned because of mistakes in planting.

The remaining trials gave very consistent results (Table I). The omission of district trials which appeared in the field to give biased comparisons makes little difference to the overall average, and the figures given in the table include all the trials harvested in the Lower River. Ginning tests were carried out separately on the replicated trials, but only on a sample of the district plots. There was little damage from bacterial blight in the Lower River, and it is therefore all the more satisfactory that A.637 has yielded better than CLB. In the last two seasons, when blight resistance conferred an advantage, all the Albars outyielded CLB by amounts ranging from 25 per cent. to over 100 per cent.

TABLE I
Cotton Variety Trials
Lint Yields in lb. per acre

Variety				Makanga	Toleza	Lower River*
CLB	..	..	..	381	367	218
CL.20	..	..	..	375	434	208
A.629	..	..	..	394	468	208
A.637	..	..	..	449	489	255
A.640	..	..	..	433	489	216
A.474	..	..	..	372	443	—
Sign. Diff. (P=.05)	..	..	..	37	43	10
S.E.	..	..	..	± 12.8	± 14.9	± 3.7
Replications	..	..	..	8	8	114
Planted	..	..	..	26:11:56	29:11:56	various

Plot size 1/145 acres. Spacing 3 ft. × 2 ft., 3 plants per hole.

* The Lower River District plots consisted of a single replication on each of 114 African cotton gardens.

District plot trials were also carried out in the central areas. There were not more than ten trials in each district, and pest damage was more severe than in the Lower River, with the result that yield differences were less consistent and not statistically significant. In general, CLB appeared poorer, and CL. 20 better, in the Central Province than in the Lower River.

Except for its lint quality, CL. 20 has given disappointing results this season. Yields have been significantly poorer than CLB; though jassid was not serious in the field trials, CL. 20 showed greater susceptibility than the other strains; and in several places it showed poorer standing ability. Added to this are the doubts expressed by Mr. Ducker and others as to its suitability for the Lower River. It has been decided therefore not to proceed with the distribution of this variety any further.

A.637 is the only one of the Albars to outyield CLB in the virtual absence of bacterial blight. It shows an all-round improvement, in yield, ginning percentage, lint quality and bacterial blight resistance, and will be multiplied to replace CLB as the commercial variety. Thirty-three acres were planted with A.637 at Toleza Farm (which is now part of the A.P.M.B. organization) this season, and was protected by dusting against stainers; a very low seed rate was used, and nearly half the area was planted with "floaters" (light seed separated during acid treatment) but the whole block averaged 700 lb. per acre of seed cotton. Next season, 200 acres will be planted at Toleza, and the remainder of the seed will be grown in a part of the Lisungwe area in the Upper Shire Valley.

Spinning tests, carried out by the Shirley Institute on the 1956 Chitala variety trial lint, gave very similar results to those shown in Table II of last year's Report. Fibre strength tests showed very little difference between CLB, CL. 20, and the Albar strains, although A. 640 and A. 645 gave rather lower Stelometer values. Lint from the 33 acres of A. 637 at Toleza is being sent to Lancashire for mill testing on a commercial scale.

ALBAR CROSSES

The Albar 49 crosses (Albar 49 $\times$ CL. 20 and Albar 49 $\times$ BP. 52 $\times$ CL. 20) were tested in variety trials for the first time. These have been rogued for susceptibility to jassid and bacterial blight, and selected for high ginning percentage and lint index over two seasons, but the results are disappointing (Table II); few of them showed improvement over CLB in yield or ginning percentage, and only two were better than A. 637. Out of 44 strains, the eight best are shown in the table and will be tested next season, but attention will be directed mainly to Albar 51 and its derivatives.

TABLE II
Albar 49 Crosses Trial
Makanga—Field 9—Trial 7/4

Variety					Yield of lint in lb. per acre		Ginning per cent.	Lint Index
					Trial A	Trial B		
CLB.	..	..	..	..	516	480	32.4	4.1
CL.20	..	..	..	..	408	422	31.5	3.9
A.637	..	..	..	..	609	600	34.1	4.3
ABC.30	..	..	..	..	566	—	31.4	4.0
ABC.31	..	..	..	..	—	568	33.4	4.3
ABC.40	..	..	..	..	—	626	32.2	3.7
ABC.109	..	..	..	..	—	561	33.0	4.4
ABC.120	..	..	..	..	512	—	33.8	4.1
ABC.124	..	..	..	..	547	—	31.2	3.6
ABC.146	..	..	..	..	—	606	34.4	4.4
AC.31	..	..	..	..	—	581	34.2	4.3
Sign. Diff. (P=.05)	..	..	..	..	67	80	—	—
S.E.	..	..	..	..	$\pm$ 23.7	$\pm$ 28.6	—	—

5 $\times$ 5 Balanced Lattices, 6 replications; each plot 1/290 acres. Planted 27.11.56. Spacing 3 ft. $\times$ 2 ft., 3 plants per hole.

Over 500 single plant selections were taken from the Albar 51 strains. Sixteen crosses have been made between Albar 51 and local and introduced varieties as follows:—

A. 629	CL. 20
A. 637	A. 618
A. 640	UK. 51
A. 474	C(50)20

A. 618 and UK. 51 are of similar lint quality to CL. 20, but C(50)20 is in a class by itself. The Shirley Institute reports that "the outstanding sample of this set was C(50)20, with a count-strength product of 2325. Most of the other samples gave values between 1900 and 2000. The high yarn strength of C(50)20 was probably due to its high fibre strength (Stelometer value 21.8) compared with values from 17 to 20 for the other samples, and to its low fibre weight." Its yield is significantly below that of the local varieties (Table III), but its crosses should be of value. Some of the newer Uganda progenies have recently been received from Namulonge for planting next season.

TABLE III
Introduced Cotton Variety Trial

Makanga—Field 3—Trial 7/3

Randomized blocks. 4 replications of 9 varieties, in plots of 1/145 acres. Planted 26:11:56. Spacing 3 ft. × 2 ft., 3 plants per hole.

Variety						Yield of lint lb. per acre	Ginning per cent.
CLB.	..	..	..	..	..	550	31.0
CL.20	..	..	..	..	..	519	30.0
C(50)20	..	..	..	..	..	421	29.5
UK.51	..	..	..	..	..	558	29.8
A.618	..	..	..	..	..	565	31.4
Standard Error	..	..	..	..	..	± 25.0	—
Sign. Diff. (P=.05)	..	..	..	..	..	74.0	—

LONG STAPLE UPLANDS

The trial at Karonga in the Northern Province was planted very late, as the usual plot could not be prepared in time after the prolonged floods of the Rukuru River. Yields were poor, and no useful information was obtained.

GINNING PERCENTAGE

Seed cotton samples from the full-scale trials in different parts of the country were roller-ginned at Makanga. The same six varieties are included in the means given below for each trial.

Trial	Location						Ginning per cent.
Chitala	Central Province	..	..	..	..	..	36.9
Toleza	Upper Shire	..	..	..	..	..	35.8
Ngabu	Lower River	..	..	..	..	..	33.1
Makanga	Lower River (1)	..	..	..	..	..	32.1
	(2)	..	..	..	..	..	34.1

These results confirm the appreciably lower ginning percentage which has been recorded for the Lower River in the past few seasons. The second trial at Makanga received 4 inches of supplementary irrigation in February and March; there is insufficient evidence to draw any conclusions from the higher ginning figure, but the possible effect of irrigation will be investigated in the coming season.

Further information on variation in ginning percentage has come to light through an examination of the records of the ginneries at Chiromo in the Lower River, and Balaka, where the Central Province crop is ginned. The Nyasaland Manager of the British Cotton Growing Association very kindly put his records at my disposal, and Table IV and Figure 1 are included with his permission.

The ginning percentage obtained at Chiromo is normally slightly lower than at Balaka, but it has fallen by about $1\frac{1}{2}$ per cent. since 1952; this was the year when the planting season in the Lower River was advanced.

TABLE IV
Ginning Percentage of Trust Land Cotton
(Grade 1 Seed Cotton)

<i>Seasons</i>					<i>Chiromo</i>	<i>Balaka</i>
1943-1948	..	..	..	..	31.40	32.00
1949-1951	..	..	..	..	(no ginning at Balaka)	
1952-1956	..	..	..	..	29.80	32.00

Chiromo ginnery normally operates for five to six months, and the monthly returns of seed cotton input and lint production have been used in Fig. 1. It will be seen that the ginning percentage rises from below 28 per cent. in April to over 32 per cent. in October, and that there is no fundamental difference between the curves obtained before and after 1952. The figures are for Grade 1 seed cotton only.

The movement of seed cotton from field to gin is bound to be irregular, depending on the opening of the markets and transport to the ginnery; deliveries in excess of ginning capacity are stored. In general, however, monthly ginnings are fairly well in step with monthly purchases; cotton stored at the ginnery usually remains in store until deliveries slow down to less than ginning capacity, and will appear in the ginnings at the end of the season.

With these limitations, the changes in ginning percentage through the season have been remarkably consistent, and are of considerable importance to the ginner and the Marketing Board. There are two possible explanations of the upward trend. As the dry season advances, from April onwards, seed cotton will dry out gradually; if the seed loses more moisture than the lint, the ginning percentage will rise. On the other hand, the difference noted in small-scale tests between the Lower River and the Central Province indicates that the inherent ginning percentage of the crop may be altered by climatic factors.

Whatever the reason for this increase in ginning percentage through the season, it must be taken into account in assessing the results of the early planting and uprooting regime, introduced in the Lower River in 1952 to reduce the incidence of red bollworm.

The histograms at the bottom of Fig. 1 show the average number of bales of Grade 1 cotton ginned each month before and after 1952. Prior to 1952, the bulk of the crop was ginned in August, September and October, with a mean ginning percentage of 31-32 per cent. Since then, June and July have been the peak months, and the average has dropped to 29-30 per cent. (see also Table IV; the means shown in Fig. 1 include more seasons than those in Table IV).

Diseases

BACTERIAL BLIGHT

Bacterial blight infection was not reported on seedling cotton, but angular leaf spot developed rapidly towards the end of January. In some areas lesions on the

stems, branches and of the growing point seriously affected growth, but this occurred mainly in fields with standing water, and some fields with poor growth where cotton had been grown for many years.

The dry weather in February checked the spread of the disease, and on the whole it caused little damage this season. The worst damage seen was to the south of Ngabu in the Lower River, near Ntakataka in the Dedza District, and in the Salima Lake-shore area.

On Makanga, what appeared to be angular leaf spot was found on some of the Albar 49 crosses, but proved to be so local and patchy that roguing and grading for resistance was discontinued. No artificial inoculation was used this season in testing for blight resistance, but equipment for this has now been obtained and will be used next year.

Fertilizer Experiment

A very heavy application of muriate of potash gave an increase in cotton yields in one experiment (Table V). The object of this trial was to see to what extent manuring and spacing could modify growth and earliness, and the high rates of fertilizer were intended intentionally to unbalance the supply of major nutrients. In fact, they had no appreciable effect on vegetative growth or fruiting pattern of the cotton; the plots were picked weekly, but no plant diagrams were recorded.

TABLE V
Manuring and Spacing Trial—Cotton

Makanga—Field 3—Trial 7/5

2×2 factorial, with split plots. 4 replications. Split plots each 1/202 acres. Planted 26:11:56.

Main plots:

Phosphate	..	..	..	..	0, 1 ton per acre superphosphate
Potash	..	..	..	..	0, 1 ton per acre muriate of potash.

Sub-plots:

12", 18", 24" spacing, 3 plants per hole, 3 root ridges.

Yields of Lint in lb. per acre

					k_0		k_1
P ₀	..	..	..	..	443	..	543
P ₁	..	..	..	..	451	..	477
Standard Error					..	±22.2	
Sign. Diff.					..	72	
12"	spacing	..	..	..	496		
18"	spacing	..	..	..	470		
24"	spacing	..	..	..	458		
Standard Error					..	±16.0	
Differences not significant.							
Interactions not significant.							

Appendix

ORIGIN AND SPECIAL CHARACTERISTICS OF THE MAIN COTTON STRAINS MENTIONED

CLB Crown Land Bulk, the commercial cotton of Nyasaland, mainly of U.4 origin.

CL. 20 .. A selection from CLB with better lint quality.

Albar A general term for selections from Nigerian Allen, highly resistant to bacterial blight. Two series of selections have been made, Albar 49 in 1949, and Albar 51 in 1951.

A. 629	}	..	Selections made at Namulonge from Albar 51, chosen as suitable for Nyasaland conditions.
A. 637			
A. 640			
A. 474			

- ABC. 30, etc. .. Selections from a panmixus bulk containing Albar 49, BP. 52, and CL. 20.
- AC. 31, etc. .. Selections from a panmixus bulk containing Albar 49 and CL. 20.
- A. 618 .. A Barberton selection from the cross MU. 8 $\times$ BP. 52 $\times$ BP. 52; widely grown in South Africa and Portuguese East Africa.
- UK. 51 .. An Ukiriguru seed issue; the commercial cotton of the Lake Province, Tanganyika.
- C(50)20 .. A Namulonge selection from BP. 52.
- U. 4 .. The jassid resistant selection made from Uganda upland by Parnell, which was the basis of much of the cotton breeding at Barberton.

Pests

(By R. C. H. SWEENEY)

Diparopsis Castanea hmps (RED OR SUDAN BOLLWORM)

The main moth-flight this season occurred from December to February with the peak emergence in early February. The peak period of egg-laying occurred in March–April.

Although the initial infestation was high, the heavy losses that were expected from Red Bollworm did not materialize and the later fruiting points set and matured with comparatively little loss from this insect. A considerable amount of early shedding, due to Red Bollworm, took place and this was most severe in parts of Port Herald and Chikwawa District. Most shedding occurred before the end of March. Shed examinations showed that between 50 per cent. and 95 per cent. of all sheds were due to Red Bollworm. Samples of green bolls showed a progressive decrease in damaged bolls and numbers of living larvae, but even the early samples showed less than 5 per cent. green bolls damaged.

The pattern this season is of interest in that it differs from those recorded in 1940–1944 by Pearson and Mitchell, whose sample gardens were mainly planted in late January. In those years the records of larvæ start at a low level in March, build-up to a peak about May, and then fall off more or less gradually.

Soil sampling for Red Bollworm pupæ after cotton uprooting in July and August showed the pupal population to be only about 160 per acre. This is considered to be low, and the numbers are very considerably less than those found at Gatooma in the same period.

The incidence of Red Bollworm in Central Province appeared considerably higher than in the Lower River.

Dysdercus spp. (COTTON STAINER-BUGS)

Stainer damage has been considerable, but apparently not as severe as in 1955–56 since the percentage of Grade 2 cotton marketed has fallen from 43 per cent. to 25 per cent. However, this is not necessarily a true indication of Stainer numbers since by no means all the Grade 2 cotton is marketed. This season over 200 lb. per acre was found in some gardens after picking in the Lower River. On the station the average figure for Grade 2 cotton was about 50 per cent. but the plants were stripped more thoroughly than in the African gardens.

The first invasion of the cotton crop came in February–March and the first species to arrive in numbers was *D. intermedius*. This species also began to leave the cotton crop in early June, some six weeks earlier than *D. fasciatus*, the other species of importance. The latter only occurred in any numbers on the crop about a month after *D. intermedius*. *D. nigrofasciatus* was never very common.

Only some 10 per cent. to 15 per cent. of green bolls were found damaged in samples from African gardens, but on the station between 30 per cent. and 50 per cent. of the locks were damaged in March. Since the samples in outside gardens were small, and having regard to the Grade 2 percentage, it is thought that the figure should be higher.

The great majority of the Stainers arrived on the cotton crop flighting from one host-tree, *Sterculia africana*, which was by far the most important pre-cotton host. This initial infestation and the F1 and F2 generations bred in the cotton, caused most of the damage this season, since few Stainers arrived on the crop after the end of the initial invasion from outside sources, and breeding in the crop was severely curtailed owing to the dry weather later in the season. Damage was apparent, however, throughout the season although most damage was caused in the earlier months.

Stainer damage was fairly uniform in the Lower River and Central Province with little to choose between the two regions.

Empoasca Facialis Jac. AND OTHERS (JASSIDS)

Like most of the other pests of cotton, Jassids were numerous at the beginning of the season and damage was noticeable in some gardens from December to early February; the numbers diminished rapidly and little or no damage was found later in the season. The situation was much the same in the Central Province. Susceptible cotton on the station was very badly damaged, however, and Jassids persisted on this variety almost throughout the season.

Earias Biplaga wlk. AND *Earias* SP. (SPINY OR EGYPTIAN BOLLWORM)

In December this species competed with Red Bollworm in numbers and damage but later in the season the damage was only minor. In some gardens it was more numerous than Red Bollworm early in the season. It was the only other bollworm of importance this season in the Lower River.

Heliothis Armigera hmphs. (AMERICAN BOLLWORM)

The moth-flight occurred at much the same time as Red Bollworm but numbers on the crop in the Lower River were very small and damage this season was negligible. In the Central Province in some areas damage was quite considerable and the population was obviously greater; it was more important than Spiny Bollworm in this region.

Anomis Flava F. (MOTH)

This species was common on the station in April and May, and the larvæ were found as the commonest caterpillars on many fields in the Chiromo area during the same period. The appreciable damage was slight, however, and the pest did not persist for long.

Sylepta Derogata F. (THE COTTON LEAF-ROLLER)

Found locally in some numbers in February and until April, tailing off in May. In Central Province, this pest was noticeably more common in May than in the Lower River. The occurrence was sporadic, however, and only rarely was any severe damage done.

Platyedra Gossypiella Saund. (PINK BOLLWORM)

This pest was only noticeable by its absence and not a single record was obtained in the Lower River. *Pyroderces simplex* Wlsm. was very common; this is a scavenger in opened bolls, the young larva of which is superficially very similar to Pink Bollworm.

Calidea Dregii Germ.

Occasional specimens only were found and it never reached pest proportions.

Oxycaraenus Hyalinipennis Costa (THE DUSKY COTTON STAINER-BUG)

Very commonly found breeding in open bolls and occurred in large numbers this season, becoming first common towards the end of March. Damage done was not assessed but some discolouration of the seed occurred.

Helopeltis Bergrothi Reut.

A small and local amount of damage was found in the Lower River but in general this pest appeared to be rare. It was commoner in the Central Province where locally around Salima, Chitala and Ntakataka some considerable damage occurred to the growing points and leaves, but boll damage was uncommon.

Zonocerus Elegans thnb. (ELEGANT GRASSHOPPER)

Some considerable local damage to seedlings occurred, the pest first occurring in numbers in early November when quite large hopper swarms were found after the first rains. In a few gardens considerable replanting was necessary. Later in the season defoliation of individual plants occurred and although damage was sometimes quite noticeable locally it was nowhere severe.

Hodotermes Mossabicus (Ag.) (HARVESTER TERMITE)

A common species very active in the early rains which occasionally did considerable damage to seedlings locally. The Elegant Grasshopper and this termite are the only two important pests of seedling cotton in the Lower River, although millipedes occasionally do some damage. In some gardens, particularly in the Sorgin area, very considerable resowing was necessary in November and December due to the Harvester Termite, but these were comparatively isolated cases. Older plants were rarely attacked.

Extract from Plant Pathologist's Report

With continuous heavy rains, bacterial blight of cotton, due to *Xanthomonas malvacearum* (E.F.S.) Dowson, spread fairly rapidly, but dry conditions in February and March prevented too heavy damage by this disease. A few bacterial boll rot lesions were found in Albar 637 plants being bulked up for seed distribution.

Also on the same Albar 637 plants, an attack of mildew caused defoliation. Also present was a leaf spot caused by a fungus thought to be *Phyllosticta gossypina* (Ell and Mont.).

A severe localized attack of Anthracnose, caused by *Colletotrichum gossypii* (Southw), occurred in one area causing some staining.

Extract from Report of Entomologist

The setting up of the Cotton Pest Research Scheme in December, 1956, has enabled a great deal of entomological effort to be applied to the problems confronting us with this crop. The first year's results are the subject of a separate Report. The past season was marked by the fact that pest attack on cotton was generally much less severe than in the previous two seasons. This was particularly true of Stainer (*Dysdercus* spp.) attack. Red Bollworm (*Diparopsis castenea* Hmps) appeared to be prevalent at the beginning of the season, particularly in the Lake-shore areas where control of Red Bollworm by the early planting regime has generally been unsatisfactory.

There was an outbreak of Cotton Stem Girdler (*Alcidodes* spp.) on cotton in the Dedza and Kota Lake-shore areas. In association with this weevil were large numbers of *Apion soleatum* Wagner, a species hitherto unrecorded in Nyasaland, although it has in all probability been confused with *Apion armipes* Wagn, in the past. The *Apion* weevils were also found in considerable numbers in the root of the plants. The attack did not appear to be causing a great deal of damage.

A species of Gall midge new to Africa was found on cotton near Balaka; it has been tentatively identified as belonging to the genus *Contarinia* but until adult material is bred out specific identification is impossible.

The Summer Cropping Regime in the Lower River

True summer cropping of cotton was introduced in the Lower River in the 1951-52 season. From that year, late planting has been prohibited, and a close season has been established from 31st July to 15th November. Planting and uprooting dates are compared in the following table:—

				Type of crop	Planting	Harvesting	Uprooting
Before 1952	..	..		Semi-summer	Jan.-Feb.	July-Oct.	31 Oct.
				Winter	March-April	Sept.-Oct.	31 Oct.
Since 1952	..	..		Summer	15 Nov.-7 Jan.	April-July	31 July

This change was made to control the damage caused by red bollworm, and was one of the alternatives recommended by Pearson and Mitchell (1945). The history of events leading up to the change is recorded by Ducker (1951).

The results of the change as measured by total seed cotton production in the Lower River have been disappointing. Average production has increased by 761 tons, an increase of only 18 per cent. (Table VI). Doubts have been expressed as to whether the change has been worthwhile, and this note is an attempt to collect all the relevant information available, and to examine some of the arguments for and against the present regime. It may as well be admitted from the start that the statistics collected have proved of little help in this examination, as they can be interpreted in various ways.

We now have six seasons' records since 1952, so I have taken for comparison six years before 1952, omitting 1949; this was an exceptional year of drought over much of Africa.

TABLE VI
Port Herald and Chikwawa Districts

Year					Seed cotton purchased (short tons)	Grade 2 per cent.	No. of growers	Seed cotton—lb.	
								per grower	per acre
1945	..	..	..	..	3,594	20	30,503	236	—
1946	..	..	..	..	3,776	26	28,532	265	—
1947	..	..	..	..	5,147	5	28,439	362	—
1948	..	..	..	..	6,793	19	39,190	347	—
1949	..	..	..	..	831	11	20,561	81	—
1950	..	..	..	..	5,327	15	35,664	299	—
1951	..	..	..	..	1,572	6	26,899	117	—
Mean (excluding 1949)					4,366	15	31,538	271	—
1952	..	..	..	..	5,778	10	20,072	576	486
1953	..	..	..	..	7,403	20	21,074	703	418
1954	..	..	..	..	5,103	19	24,257	421	373
1955	..	..	..	..	6,713	31	28,452	472	372
1956	..	..	..	..	2,183	44	19,654	222	193
1957	..	..	..	..	3,582	25	17,519	409	397
Mean					5,127	25	21,838	467	373

RED BOLLWORM

The summer cropping regime has resulted in considerable control of red bollworm. There are no population records to compare with those of 1939-44, but observations in the past two seasons, and records made in 1956-57 on and around Makanga, both support this conclusion. Pearson (1957), comparing the position in June, 1956, with that in 1939/44, concluded that "the new regime in the Lower River is giving sufficient control of red bollworm to permit the setting of a very large potential crop". Production per grower (see below) has increased by 75 per cent., and yield of seed cotton has averaged 373 lb. per acre since 1952, quite a satisfactory figure for African-grown cotton.

MIXED CROPPING

Rapid growth and early setting of the crop was considered essential to the success of the new regime. Intercropping of cotton with maize and bulrush millet was the practice when much of the crop was grown on seasonally flooded land, and survived the move to dry land cultivation when the Lower River marshes were permanently flooded. As this practice delayed the growth of cotton, it was prohibited when the change to summer cropping took place, and since 1952 cotton has been grown in pure stand only. This has also resulted in a much better standard of cultivation, and has contributed to the higher yields obtained.

Dry land cotton, dependent on rainfall, gives its best yield when planted early. In mixed cropping, cotton was invariably planted after the maize had been established; the closer together the planting dates, the more deleterious was the effect on the cotton. Early planting was therefore impossible with intercropping, and the crop harvested in the extra three months to 31st October, often negligible, was not sufficient even in a season of late rains to make up for late planting. A comparable yield could only be achieved on seasonally flooded land.

GRADE 2 COTTON

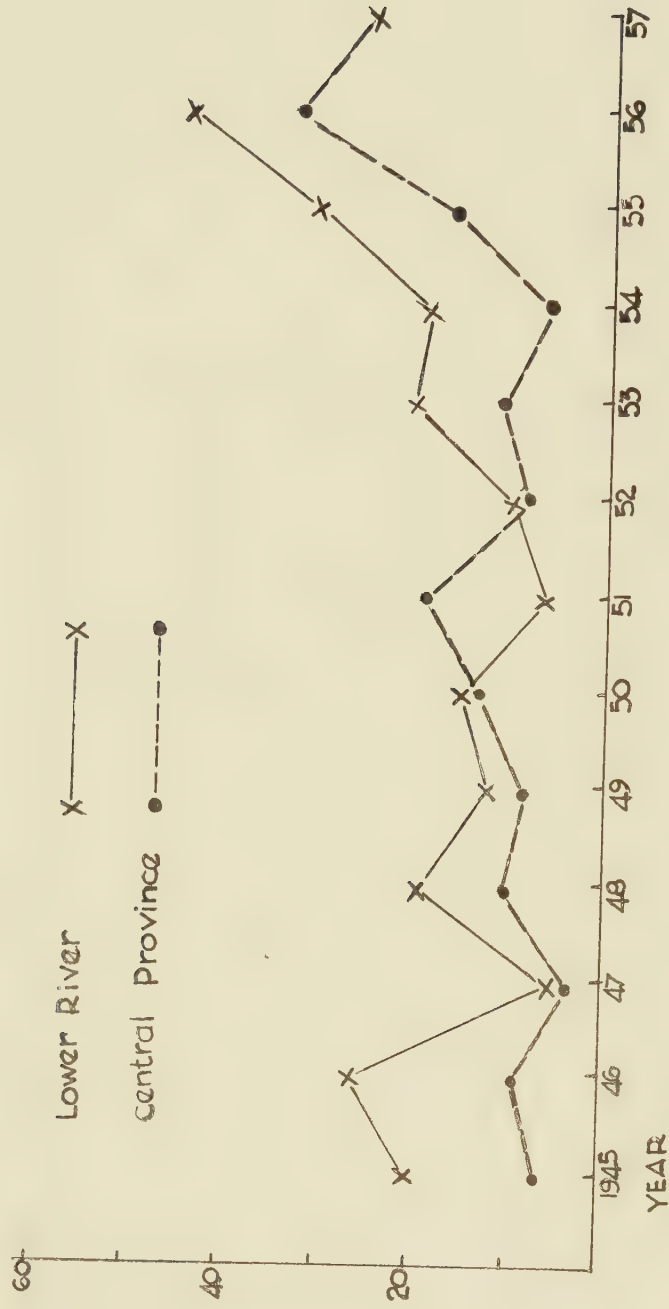
From 1952 to 1956, Grade 2 cotton increased from 10 per cent. to 44 per cent. of the total bought; in 1957 it was 25 per cent. Observations in the last two seasons indicate that this is mainly the result of increased damage by cotton stainers, and the question arises whether this increase is due to the change in the planting season.

The percentage of Grade 2 cotton bought is a reflection of the amount of stainer damage, but cannot be accepted as more than an approximate measure. It is affected by the prices offered for the two grades; a varying amount of Grade 2 cotton is left unpicked in the field; many bolls damaged at an early stage never produce any pickable cotton; and other pests and diseases are responsible for an unknown proportion of the damage. In the absence of stainer records, however, the percentage of Grade 2 is the best measure of stainer damage that we have over the 13-year period.

There appear to be two independent factors affecting stainer damage. Cotton under the new regime is carrying its first crop of green bolls in March, when the stainers are leaving their main alternative host, *Sterculia africana*, and some of the increase in stainer damage can be ascribed to this factor. Stainer breeding, on the other hand, depends on climatic factors, particularly moist soil conditions for hatching and survival of the young nymphs. Late rains encourage stainer breeding in the cotton crop.

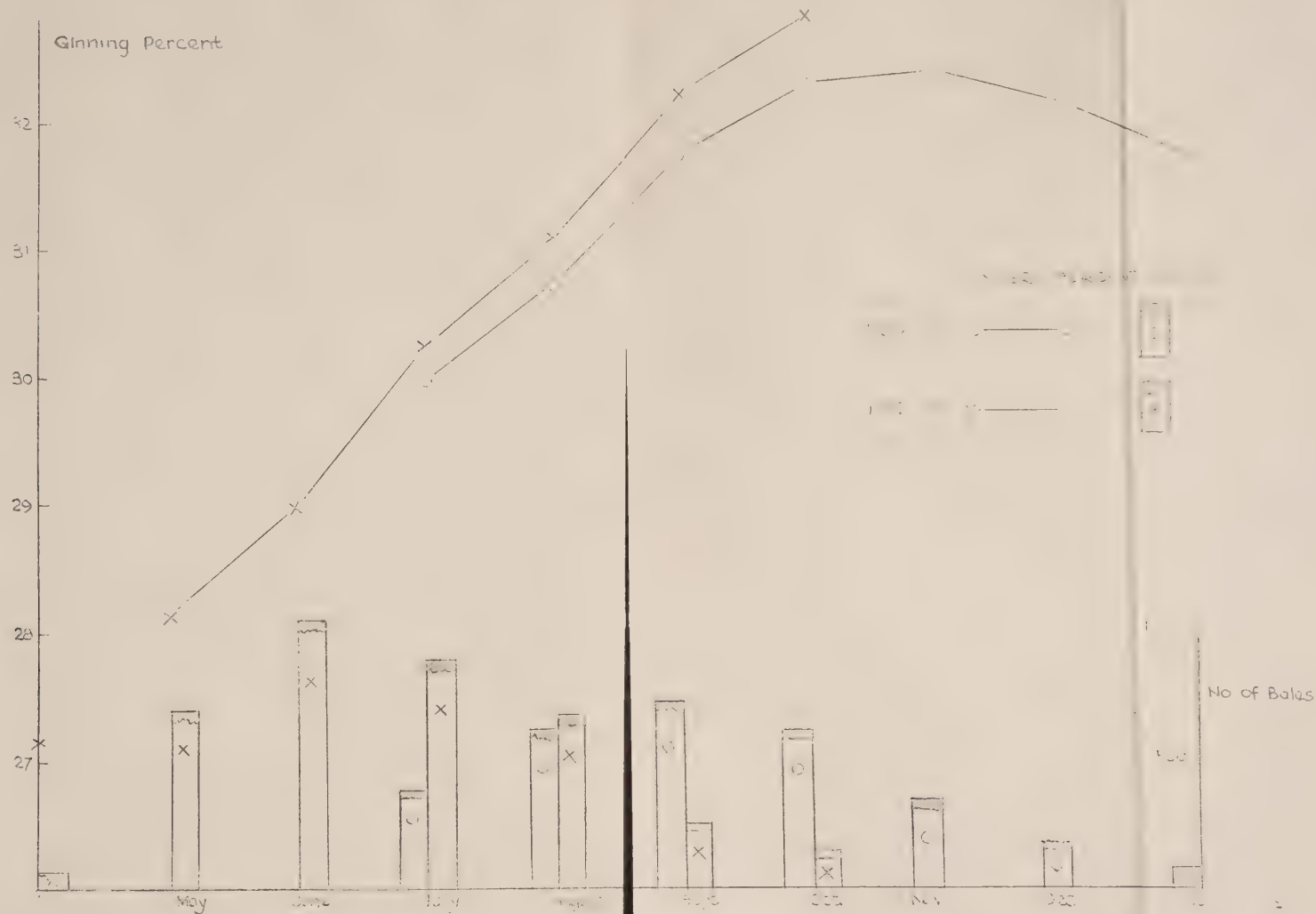
Fig. 2 compares the Grade 2 percentage in the Lower River and the Central Province. As a working hypothesis, the correspondence between the two curves can be attributed to generally similar climatic conditions for breeding; the higher average in the Lower River throughout the 13-year period can be attributed to differences in

Grade 2 Percent



PERCENTAGE OF GRADE 2 SEED COTTON PURCHASED

CHIROMO GINNERY — MONTHLY GINNING PERCENTAGE AND AVERAGE OUTPUT OF TRYSTLAND COTTON



the relationships between cotton and the wild stainer hosts in the two areas; and the residual difference before and after 1952 to the effect of the new regime in the Lower River. On this hypothesis, the average increase of 7 per cent. since 1952 in the Central Province, where summer cropping has been generally practised since before 1945, measures the effect of climatic factors, and the additional 3 per cent. increase in the Lower River is due to the new regime.

GINNING PERCENTAGE

The effect of the new regime on ginning percentage has been discussed in the foregoing report. It was shown that the commercial ginning percentage has fallen by about 2 per cent. since the introduction of summer cropping.

PRODUCTION PER GROWER

The success of a new cropping policy is usually measured by yield per acre. In the present case, the simultaneous change from intercropped to pure stand cotton makes it impossible to estimate the effect of bollworm control by this means. An alternative measure is the production per grower. Unfortunately, the accuracy of the number of growers reported each year is open to question. The number is estimated in two ways; in the first instance a count is made of the first issues of seed to growers from each store, and later a garden census is taken during the growing season. Both these methods are subject to considerable errors, and it is not always certain which method has been used. The figures will, however, indicate major changes from year to year.

The production per grower rose substantially after 1952, but this increase has been largely offset by a reduction in the number of growers. This appears inconsistent: it is unlikely that the grower would increase his production if the crop was not profitable; on the other hand, if yields have increased, why have more growers not taken to cotton?

Explanations of this inconsistency are at present largely a matter of speculation, but it is probably the key to the absence of any substantial increase in production. It may be argued that the new regime has introduced competition between cotton and food crops at planting and harvest time; that the smaller and less efficient growers have gone out of production; that growers have been discouraged by strict enforcement of the cotton rules; that uprooting by 31st July is unpopular, especially when the plants are carrying green bolls; that economic incentive is lacking; and so on.

It is worth noting, however, that the numbers of growers showed a steady increase up to 1955. The drop in 1956 was largely due to very difficult planting conditions; in north Chikwawa the first rains came in January. The poor yields in 1956, in which the heavy stainer attack played an important part, probably discouraged many people from planting cotton in 1956/57.

DISCUSSION

The lack of conclusive evidence in favour of the summer cropping regime does not mean that it has been a failure; there is an equal lack of evidence that things were better as they were.

The two valid criticisms which have emerged are the drop in ginning percentage, and an increase in stainer damage; but a substantial part of the latter can be attributed to climatic factors.

Production has increased since 1952, in spite of the heavy stainer attacks in 1955 and 1956. Unfortunately, it remains an open question how much of this increase is due to bollworm control, pure stand cotton, early planting, more extension staff, better marketing, and better prices. It may be mentioned here that pure stand cotton would not have been introduced without early planting; it was expected to be one of the main difficulties in the changeover.

Any relaxation in the present summer cropping regime would be a serious danger to the Lower River cotton crop. Red bollworm control now shows a marked contrast to the position in the Central Province, where production has fallen from an average of 1,200 tons per annum to under 200 tons, largely because of red bollworm. The intensity of the attack there is a recent development; as recently as 1952, Ducker (1952) reported that "the close season . . . in all areas . . . has resulted in a good control of red bollworm. Experience at the Cotton Research Station (Chitala) suggests that this can be maintained indefinitely" In 1955, the position had changed considerably—"In the central areas represented by Chitala, the close season measures at present in use do nothing appreciably to control the ravages of red bollworm." (Ducker, 1955.)

The red bollworm is not easy to control, even with the use of insecticides. Rather than lose the ground already gained, the Department of Agriculture is concentrating on methods of controlling stainers, which may prove vulnerable on their wild host trees. Control of these two major pests is essential for sound development of cotton production in the Lower River.

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ROTATIONS

1. EFFECT OF CROP UPON CROP AND LENGTH OF ROTATION

In experiments at Chitedze and Tuchila, designed to test the effect of various crops on the succeeding crop, maize and tobacco did best after velvet bean green manure and groundnuts, and groundnuts equally well after maize, tobacco or green manure.

TABLE I
Effect of Preceeding Crop on Maize, Groundnuts and Tobacco Yields

<i>Station and crop 1956/57</i>				<i>Yields lb./acre grain, shelled nuts or cured leaf</i>			
				<i>After maize</i>	<i>Green manure</i>	<i>Groundnuts</i>	<i>Tobacco</i>
Chitedze maize	..	..	..	3,320	4,480	4,230	3,845
Tuchila maize	..	..	..	2,970	4,225	3,650	3,165
Chitedze groundnuts	..	..	..	1,040	1,100	880	1,085
Tuchila groundnuts	..	..	..	1,350	1,410	890	1,325
Chitedze tobacco	..	..	..	527	522	598	184
Tuchila tobacco	..	..	..	647	798	592	487
							<i>L.S.D.</i>
							680
							none
							125
							285
							123
							122

It doesn't pay to grow a crop on the same piece of land for two successive years, especially tobacco and groundnuts.

The value of leguminous green manures and groundnuts in boosting maize yields has also been shown in other long-term rotation experiments at Chitedze, Mbawa and Tuchila. At Chitedze these boosted maize yields do not cause depressions in yield in the crop following, i.e., the second successive maize crop after groundnuts is as good as the second successive maize crop after, say, bush fallow.

On the rich and fairly virgin soil of Chitedze maize yields averaged about fifteen bags per acre unfertilized in rotation experiments. There was surprisingly little fall-off in yield in the third and fourth successive maize crops, though maize does better after early ploughed bush fallow, pigeon pea, groundnuts and green manure than after maize. There is a marked response to sulphate of ammonia, especially after fallows newly ploughed and in the second successive maize crop. It appears from interim observations on these good red sandy clay loams that fairly long arable breaks can be taken (five or six years at any rate), that two consecutive crops can safely be grown if necessary and that nitrogen is the limiting nutrient and should be supplied to tobacco or maize in the rotation.

On the worked-out soils of Tuchila there is a very marked fall-off in yield in the third to fifth successive maize crop. Unfertilized yields averaged four bags per acre but 100 lb. per acre S/A increased yields by three to four bags or more in all treatments. On this soil one can have only a short three or four year arable break before a period of rest or green manuring, maize should not be grown two years in succession and farmyard manure and nitrogenous fertilizer should be applied wherever available.

On the poor sandy soils of Mbawa there is an even greater reduction in yield of successive maize crops than at Tuchila, the soil tires more quickly and is more liable to erosion. This year's maize yields were virtually a failure in the Rotation No. 1

experiment, averaging about one bag an acre unfertilized. 100 lb. per acre S/A increased yields to three or four bags. Short arable breaks of three years only can be taken on this soil if no fertilizer is used and two successive maize crops are rather a waste of time unless very heavily manured. Both nitrogen and organic matter are very much limiting factors in this soil and responses are often obtained to superphosphate as well. With adequate farmyard manure and fertilizer in a good rotation, excellent yields of maize have been obtained, e.g., the thirty bags per acre of S.R. Hybrid maize obtained in the Federal trial this year, but these soils must be well, farmed if they are not to be exhausted by three or four years cropping. Fortunately cattle in this area are fairly numerous and farmyard manure could be made.

2. EFFECTS OF LEYS IN ROTATION

Preliminary experiments on the effects of leys in restoring fertility to worn-out land show that some caution is needed. The leys must be properly managed if they are to serve this purpose. Rhodes grass leys with their dense mat of roots certainly improve the soil crumb structure temporarily and add raw organic matter to the soil. Unless carefully managed with legumes in the mixture or well supplied with nitrogenous fertilizer they do tend to drain the nutrient reserves of the soil, notably nitrogen, especially if only cut for hay. On nearly all Nyasaland soils nitrogen is the limiting factor and unless a ley is carefully managed it is possible to render the nitrogen in the soil unavailable to the succeeding crop. Without the addition of a considerable amount of artificial fertilizer the best way to do this is not yet fully clear.

This year at Chitedze, maize crops grown after a four-year-old Rhodes grass ley, managed for hay, and ploughed in with a 2-3 feet growth of grass in March/April did very poorly, showing marked signs of nitrogen starvation. The maize responded markedly to dressings of sulphate of ammonia while superphosphate tended to enhance the nitrogen deficit. Ordinary bush fallow gave better maize yields, but there is little doubt that maize is happier on second or third year land after a groundnut or well fertilized tobacco crop. Groundnuts are not as sensitive to nitrogen shortage as tobacco or maize and do quite as well on newly opened land as after a maize or tobacco crop. Tobacco, though suffering from nitrogen shortage, is being to a greater and greater extent manured and fertilized and does quite well on new land.

TABLE II
Maize, Groundnut and Tobacco Yields on newly ploughed resting land as compared with second year Arable

Varieties: Namalenga, Mwitunde, Western.

Yields; lb./acre shelled seed or cured leaf

<i>Crop with fertilizer in 1956/57</i>	<i>After maize</i>	<i>Groundnuts</i>	<i>Tobacco</i>	<i>Bush</i>	<i>Rhodes</i>
Maize + nil	1,920	2,925	3,305	2,505	1,200
Maize + 100 lb. S/A	2,640	3,560	3,820	2,765	1,765
Maize + 200 lb. S/A	3,130	3,460	4,360	3,185	2,070
Groundnuts + nil (a)	965	885	1,160	1,190	1,140
Groundnuts + nil (b)	915	—	1,005	1,050	—
Tobacco + nil	—	445	—	360	—

A Rhodes grass fertilizer trial receiving annual applications of 0-1,200 lb. per acre sulphate of ammonia in one dose at the beginning of the rains for three years was ploughed up and planted to maize. The grass was hayed once a year. The soil was stiff with undecomposed roots and still is after one crop has been grown. Maize yields were miserable and an increase was obtained only from the two highest dressings, over 3,000 lb. per acre fertilizer in three years.

GRASSLAND EXPERIMENTS AND OBSERVATIONS

1. RHODES GRASS MANAGEMENT TRIAL AT CHITEDZE

In a management trial on Rhodes grass at Chitedze, using only the mower, yields followed the pattern of the previous years. Uniform increases in yield have been obtained to dressings of up to 400 lb. per acre of sulphate of ammonia. This dressing should be split and applied just before each period of growth in the management cycle, with a bias in favour of mid-season applications. The first flush of growth is usually pretty vigorous, but the second and third crops need stimulating. There is not much residual effect of a dressing after the cut has been taken; each cut should have its own dressing at the beginning of its growth period. It seems that Rhodes grass cannot stand more than three cuts in a wet season at Chitedze, unless, possibly, it is very heavily fertilized. At the Tung Station, however, it has been cut monthly under the rather more uniformly damp climate. A treatment intended to be cut four times at Chitedze showed practically no regrowth after being cut in January, February and March. Two cuts per season, taken in early January and March, are probably best, giving a better quality hay though of slightly lower yield than that obtained in a single cut in March. If more than two cuts are taken the yield drops steeply—10 tons per acre green material in two cuts and 4.5 tons per acre green weight in three cuts.

2. FERTILIZER TRIAL ON MAKARIKARI AT MBAWA

A fertilizer trial on Makarikari at Mbawa, using grazing hours checked by sample cuts as measure of production, showed large and uniform increases from dressings of 300 to 600 lb. per acre sulphate of ammonia applied in two dressings, one at the onset of the rains and one in late January. 600 lb. per acre of superphosphate gave no increase, and dung at 5 tons and 10 tons per acre but little. In both years in which the experiment has been recorded the grass has averaged 46 grazing days per acre. Figures given for Makarikari in Kenya in 1951 by Pereira and Beckley on eroded soil show it to give 43 grazing days per acre, with Rhodes grass at 62 and Star grass at 21 days per acre.

3. OBSERVATIONS ON CARRYING CAPACITY OF RHODES GRASS AT TUCHILA

At Tuchila two six-acre strips of Rhodes grass, established in 1954/55, were fenced off and one only was given 200 lb. S/A per acre at the beginning of the rains. Each strip was grazed with four well-matched bullocks, their range being restricted by an electric fence to that area of grass which they could keep well grazed. Grazing began on 16th January, 1957, and whereas the bullocks on the unfertilized grass managed to keep it short and young and made weight, the ones on the fertilized Rhodes were too few in number to keep the grass under control, and owing to the rather rank growth on the area to which they were confined actually put on less weight than their rivals over the fence. The six acres unfertilized kept four bullocks in good trim for 157 days grazing, whereas $3\frac{1}{2}$ acres of fertilized Rhodes were more than the same number could cope with in the time. It was concluded that, as a working basis, unfertilized Rhodes could carry one beast per two acres during the rains and Rhodes treated with 200 lb. S/A per acre could carry one beast per acre. Sample cuts taken from the area at silage stage gave unfertilized grass a yield of $2\frac{1}{4}$ tons per acre green material, while the fertilized grass yielded $5\frac{1}{2}$ tons per acre green. The effect of the fertilizer was visible ten days after application.

4. OBSERVATIONS ON GRASS VARIETIES THROUGHOUT TERRITORY

A number of new grasses were introduced to the Chitedze nursery last February from Uganda and Tanganyika and multiplication plots of some of the more promising of the older varieties planted. On mixed plots, Rhodes grass, Makarikari and *Setaria* are most favoured in the rains, while *Cenchrus* gains favour towards the beginning of the dry season, when it is much greener than most other varieties. *Brachiaria decumbens*, *Paspalum dilatatum* and various strains of *Cynodon* such as those from Muguga and Machokos have covered well, but do not seem as palatable as the Rhodes and Makarikari. In the *dambo* and elsewhere *Paspalum notatum* swards have been established in a season from three- or four-year-old seed. The most competitive introduced grasses in the *dambo* are the *Paspalums*, *P. notatum*, *P. dilatatum* and *P. urvillei* and *Acroceras macrum* (Nile grass) which spread well and are grazed down to a fine sward. These have persisted there for five or six years now. Rhodes and Star grasses also take and grow, but are inclined to die out after three or four years. Uneroded *dambo*, when ploughed quickly, reverts to its indigenous grass cover which competes violently and usually swamps any introduced species planted.

There is nothing new of importance to report on legumes, but enough seed has now been collected to sow next season a whole series of grass legume mixtures chequer board fashion.

In Karonga District various varieties have been planted round the country. In the Misuku, Rhodes grass, *Paspalum urvillei*, *P. dilatatum* and *Digitaria waterfall* were most promising and plots of New Zealand wild white, Ladino and a local clover were established. On Yembe Hill, Makarikari and Nile grass are doing well on deep soil in a valley bottom, while Makarikari, Star grass, *Digitaria* sp. and *P. urvillei* are doing well on thin stony upland soil. At Baka, on the Lake-shore, Makarikari *P. dilatatum*, *P. urvillei* and Vetiver grass grew well, while Molasses, Rhodes, Star and Nile grass, and *P. notatum* and *Digitaria* sp. did poorly.

On the slopes of the Nyika Plateau, mile 22, Star grass has been outstanding and has spread at the expense of all the other varieties. Nile grass, *P. dilatatum* and *P. urvillei* have not spread much but have formed a good sward and maintained themselves well. On the high Nyika, Kikuyu grass flourishes. At Nchenachena, *Trifolium johnstonii* thrives and persists well.

In South Mzimba, *Stylosanthes gracilis* has grown well and the stock at Mbawa have learned to relish it. It grows well with Makarikari and Rhodes grass and seed supplies are being bulked up at Mbawa for distribution to Master Farmers.

"Museum" plots, 1/80th acre in size, have been established at Bvumbwe for a preliminary growing of grasses and legumes. In these plots the following have been noted:—

CLOVERS : Growth was unsatisfactory without irrigation. Mt. Barker and mixed early and mid-season strains of subterranean clover germinated well during the rains from own sown seed but many seedlings died as a result of waterlogging. Nodulation was good; a top-dressing of superphosphate was applied. Growth was poor. Growth of *Trifolium johnstonii* was checked by the heavy rains of January and April. Individual plants of Bokhara or Sweet Clover (*Mcililotus alba*) grew well and, although nodulation generally was good, growth was very uneven and plants quickly died out with the dry season.

RHODES GRASS (*Chloris gayana*): The "Katambora" Strain is finer-leaved and less vigorous than "Mpwapwa" but remains greener in dry season and could profitably be grown in a ley mixed with it.

Paspalum Notatum: The Pensacola Bahia and the Paraguay Bahia strains of *P. notatum* have been selected from these plots for trial as a pasture under tung.

COLUMBUS GRASS (*Sorghum alnum*): The heavy rains induced devastating attacks of rust. It would be more suited to a drier climate.

Further one-acre grass/legume plots have been established for grazing trials. The most promising plots so far are of the following mixtures:—

Mpwapwa Rhodes with *Desmodium intortum* or *Glycine javanica*.

Cenchrus ciliaris with *Stylosanthes gracilis* or *Desmodium intortum*.

Star No. 2 (*Cynodon plectostachyon*) with *Aeschynomene americana* or *Desmodium intortum*.

Makarikari with *Desmodium intortum*.

The best grazing on the plots so far established has been provided by *Cenchrus* (3359), Makarikari (2637), Star Grass (2379), Rhodes (2172) and Napier (968), the number representing the cattle head hours of grazing which each plot was able to provide. The protein content was determined by the laboratory (see Chemist's Report); it was possible to double the feeding value of a pasture (i.e. to 28 per cent. protein) by incorporating the legume *Desmodium intortum*. This legume is well-suited to Bvumbwe conditions and, being a deep rooted perennial, is able to provide a green bite in the dry season.

The utilization of Rompha with its high protein content (see Chemist's Report) presents a problem. At the moment a pure-stand planting is being used for occasional grazing, for cutting green for stall feeding or turning into hay; the hay contained 16 per cent. protein.

FERTILIZER TRIAL IN RHODES GRASS

The table below shows the yields obtained over four years from the Teso strain sown in February, 1952. Fertilizers used were sulphate of ammonia (S/A) and nitramoncal (N/A).

TABLE I
Yields of Air-dry Rhodes Grass Hay in short tons per acre

Nitrogen Application						1954	1955	1956	1957	Mean
Nil	..	..	..	..	..	2.6	2.3	2.8	1.6	2.4
100 lb./acre S/A every 3 months	..	..	..	..	..	6.0	7.4	6.7	5.1	6.3
200 " " " "	..	..	..	..	..	7.1	9.2	8.8	6.5	7.9
300 " " " "	..	..	..	..	..	8.8	11.9	11.1	8.6	10.1
100 " " every month	..	..	..	..	..	7.6	11.3	15.8	14.6	12.4
100 " " N/A every 3 months	..	..	..	..	..	4.6	6.0	7.2	5.2	5.8
200 " " " "	..	..	..	..	..	5.2	7.2	7.2	5.9	6.4
300 " " " "	..	..	..	..	..	5.9	8.0	8.8	7.7	7.7
100 lb./acre N/A every month	..	..	..	..	..	5.1	8.9	9.9	12.9	9.2
Mean ..						5.9	8.1	8.7	7.6	—

L.S.D. ($P=0.01$)

Two fertilizer treatment means	..	..	..	2.4
Two season means	..	..	..	0.5
Two season means for a given fertilizer treatment	..	..	..	1.5
Two fertilizer treatment means for one season	..	..	..	0.6
Coef. of variation	..	..	..	12.5 per cent.

The experiment has demonstrated the greatly increased yields to be obtained from fertilizer applications and has shown the superiority of sulphate of ammonia over nitramoncal (nitrochalk).

Over the four years there has been a steady increase in yield but it is apparent that after five years under Bvumbwe conditions a reduction in yield can be expected; hence the recommendation that Rhodes grass best be suited for use in a ley. A further factor is apparently the acidifying effect of sulphate of ammonia over the period of years (*see* Chemist's Report). The plots receiving nitramoncal have responded increasingly; it also appears from the above table that this year a stage has been reached where the decrease in the crop due to age has been less in proportion in the nitramoncal plots than in the sulphate of ammonia plots.

An analysis of the protein content (percentage dry weight) during the grazing season showed that this varied in the same manner as the yield per acre, i.e., with increased applications of fertilizer (*see* table below and Chemist's Report). Similarly, when a uniform dressing is applied at different times of the year (i.e. 100/1 and 300/3) the difference of protein content varies in the same manner as the difference in yield. There appears to be two flushes of growth.

TABLE II
Rhodes Grass—Yield per acre in short tons compared with Protein Content

Treatment	November		December		January		February		March		Means	
	YPA.	Prot.	YPA.	Prot.	YPA.	Prot.	YPA.	Prot.	YPA.	Prot.	YPA.	Prot.
Control	0.21	9.7	0.14	8.3	0.13	6.2	0.17	7.6	0.16	8.5	0.16	7.5
100/3 S/A	0.40	11.4	0.49	14.9	0.33	8.4	0.44	11.6	0.46	9.1	0.36	10.0
200/3	0.54	13.5	0.57	8.6	0.42	11.0	0.57	10.5	0.77	8.4	0.58	10.4
300/3	0.85	16.8	0.68	11.2	0.52	10.2	0.70	11.5	0.90	9.6	0.73	11.9
100/1	1.84	20.5	1.65	14.1	1.04	12.5	1.00	13.7	1.12	18.2	1.33	15.8
100/3 N/A.	0.60	10.0	0.47	8.1	0.40	6.8	0.47	7.3	1.02	6.6	0.59	7.8
200/3	0.77	11.6	0.51	10.4	0.33	13.5	0.58	10.4	0.41	12.8	0.52	11.7
300/3	0.89	13.1	1.13	12.3	0.55	11.7	0.66	9.6	0.53	11.5	0.75	11.6
100/1	1.50	18.1	1.20	16.7	1.05	10.9	1.07	12.2	0.62	12.5	1.08	14.1
Means	0.71	13.6	0.76	11.6	0.53	10.1	0.63	10.5	0.66	10.2	—	—

Extract from Report of Agricultural Chemist, Bvumbwe

1. EFFECT OF NITROGEN APPLICATION

Periodic samples from the ammonium sulphate, nitramoncal experiment at Bvumbwe were examined for protein content, the figures being as follows:—

TABLE III
Percentage Protein

				1956				1957			
				Aug.	Oct.	30/11	31/12	31/1	27/2	29/3	2/8
N/A 100/1	..	..	..	—	—	18.1	16.7	10.9	12.2	12.5	7.6
S/A 100/1	..	..	..	—	—	20.5	14.1	12.5	13.7	18.2	8.7
N/A 100/3	..	..	..	—	—	10.0	8.1	6.8	7.3	6.6	5.1
S/A 100/3	..	..	..	9.2	7.2	11.4	14.9	8.4	11.6	9.1	5.6
N/A 200/3	..	..	..	—	—	11.6	10.4	13.5	10.4	12.8	6.4
S/A 200/3	..	..	..	—	—	13.5	8.6	11.0	10.5	8.4	6.7
N/A 300/3	..	..	..	—	—	13.1	12.3	11.7	9.6	11.5	6.8
S/A 300/3	..	..	..	—	—	16.8	11.2	10.2	11.5	9.6	10.0
Control	..	..	..	7.1	6.0	9.7	8.3	6.2	7.6	8.5	4.9

From these figures, ammonium sulphate 100 lb./month gave the highest protein content (13–20 per cent. depending on the month), nitramoncal at the same rate gave 11–18 per cent. 300 lb. every three months gave 10–17 per cent. protein with S/A, and 10–13 per cent. with nitramoncal. At 200 lb. every three months, S/A gave protein contents of 9–14 per cent. and the nitramoncal was slightly better at 10–14 per cent. At the lowest rate of 100 lb. every three months, the S/A gave 8–15 per cent. protein and the nitramoncal only 7–10 per cent., this being hardly better than the control (6–10 per cent.)

Considering the monthly variation, the protein content was highest in November, and decreased to its lowest point at the end of January, increasing again to the end of March and decreasing again in August.

The following figures for full composition of the pastures are also of interest, although such information was not obtained on all samples.

TABLE IV

				November			August		
				Oil	Fibre	Sol. carbohydrate	Oil	Fibre	Sol. carbohydrate
N/A/100/1	..	..	..	—	—	—	1.90	31.8	58.7
S/A/100/1	..	..	..	2.56	22.8	54.1	2.18	28.2	60.9
N/A 100/3	..	..	..	—	—	—	1.66	32.1	61.1
S/A 100/3	..	..	..	—	—	—	1.93	30.8	61.7
N/A 200/3	..	..	..	—	—	—	1.80	31.2	60.6
S/A 200/3	..	..	..	—	—	—	1.67	30.5	61.1
N/A 300/3	..	..	..	1.53	30.6	54.8	2.46	30.2	60.5
S/A 300/3	..	..	..	1.72	27.8	53.7	2.13	31.0	56.9
Control	..	..	..	2.29	27.5	60.5	1.78	29.6	63.7

The increase of oil content with nitrogen is variable and although there is an indication that S/A is slightly better, the difference is not consistent. Nitrogen tends to increase the fibre, the effect of nitramoncal being slightly worse than ammonium sulphate. It is, however, noted that at 100 lb. per month, the sulphate of ammonia not only increases the protein content, but the fibre is also reduced below that of the control.

2. COMPOSITION OF VARIOUS GRASSES

The following figures were obtained from the protein content of grasses grown in other trials:—

TABLE V
Per cent. Protein on Dry Material

				Nov.–Dec. cut		Jan.–Feb. cut	
				1st	2nd	1st	2nd
Cenchrus	..	..	..	13.7	19.4	—	—
Makarikari	..	..	..	14.9	11.6	—	—
Napier	..	..	..	13.8	14.9	13.8	14.3
<i>Pasp. Dilatatum</i>	..	..	..	12.4	12.6	9.1	13.4
„ <i>Notatum</i>	..	..	..	11.4	11.2	—	—
„ <i>Urvellei</i>	..	..	..	15.3	14.8	11.9	13.4
Rhodes grass	..	..	..	12.4	13.2	—	—
Star grass	..	..	..	10.5	8.7	14.1	10.0

Cenchrus had the highest protein content, the order of the others being (2) Makarikari—Napier and *Pasp. Urvellci*. (3) Rhodes (4) *Pasp. Dilatum* and *Notatum* with the lowest content occurring in Star grass. A legume/mixed grass pasture was found to contain 28 per cent.

Reference here may be made to Rompha grass as its higher nitrogen content is attractive. A sample contained 24 per cent. protein, and the corresponding hay 16.0 per cent. protein. It had been reported from Southern Rhodesia that sheep fed on Rompha grass had shown an illness similar to that caused by cobalt deficiency in New Zealand.

Cobalt contents of Rompha grass were examined and found to be 0.13–0.15 ppm. This was within the recognized satisfactory levels for pastures, and agreed with figures obtained on Southern Rhodesian samples. However, from feeding tests, it appears that it may not be a direct cobalt deficiency which is involved, but rather a greater concentration of toxin.

3. SOIL ACIDITY

In the 1954–55 Report reference was made to the acidifying action of ammonium sulphate on pastures and last year's Report referred to laboratory investigations into this problem. The same effect has been noted in the above experiment, the pH values being as follows:—

						100/1	100/3	200/3	300/3	Control
S/A	0–6"	..	..	..	..	4.8	5.8	5.3	4.9	6.4
	6–12"	..	..	..	..	5.2	6.0	5.9	5.2	6.3
N/A	0–6"	..	..	..	..	6.4	6.2	6.6	6.5	6.3
	0–12"	..	..	..	..	6.6	5.9	6.4	6.2	6.3

It is noted that the 100/1 S/A has about the same effect as 300/3, as would be expected. The higher amounts of nitramoncal tend to increase the pH of the soil very slightly.

The varying levels of nitrogen do not appear to affect the other soil constants appreciably—these being:

Org. C. per cent.				N per cent.	P ppm.		Base cap.	K m.e.p.c.
					Av.	Res.		
1.8–2.4	..	..		0.121–0.149	9–30	50–90	6.8–9.0	0.1–0.45

There did appear to be some depletion of potash, as this was generally lower on the sulphate of ammonia plots, but it is difficult to make any firm conclusion, as samples from each plot were not taken before the experiment began. However it may be significant that the control plot has a higher K content than any of the others.

REPORT OF THE TEA RESEARCH STATION

Unless otherwise stated the results reported refer to the crop season July, 1956, to June, 1957.

Two new field experiments were started, one at Bandanga Estate in Cholo District and the second at Lauderdale Estate in Mlanje. In both cases the experimental design was a simple diagnostic, "two-cubed" N.P.K.

At the beginning of the season the important decision was made by the Tea Research Committee to move the research staff resident at Swazi to Mimosa. Unfortunately, financial limitations have delayed this move and it appears that the transfer may not be completed before July, 1958, at perhaps the earliest. In the meantime and in anticipation of this move some of the older experiments at Swazi have been closed down and any new developments have been automatically initiated at Mimosa.

An equally important decision was to open a sub-station in Cholo as soon as land and funds are available and to this end sufficient seedlings have been planted in the Mimosa nurseries for one replication of the Shade x N.P.K. Experiment and for the Complex Experiment.

Throughout the season labour was adequate on both stations to maintain reasonably short plucking and weeding rounds but, unfortunately, the same conditions did not obtain for some of the estate experiments and as a result the standard errors of these increased.

The season was an excellent one for crop albeit the total rainfall for the season in Mlanje was below average. Investigations into rainfall-crop relationship have taken a big step forward during the year and although these are empirical and not yet completed, it appears that good early rains are of overriding importance. Thereafter the expectation of rainfall is good enough to keep soil moisture reserves high. This season the early rains were excellent in distribution and quantity and although February heralded an abrupt change in rainfall the smaller than average amounts thereafter until the end of the main crop season were enough to replenish soil moisture losses. The net effect has been record crops on a below average total rainfall. A picture that would not appear if total rainfall for the season was the sole criterion.

In March, 1957, purity tests were completed on the first group of seed gardens to be examined under the Seed Certification Scheme and resulted in the award of one Grade I Certificate (not more than 0.1 per cent. hybrid types) and two Grade III Certificates (not more than 1.0 per cent. hybrid types). In this group seed from seven Nyasaland seed gardens was submitted for test.

NURSERY EXPERIMENTS

In paragraphs 19, 20 and Table II of the 1955/56 Report, data were listed which show that average and orthodox 30-month-old nurseries cannot be considered efficient in producing stumps of the required diameter for uprooting and successful transplanting. Consequently there is a need for research into nursery techniques.

Over the past years, various nursery experiments have been conducted and though few of them yielded conclusive results, considered as a whole they have produced sufficient information to offer starting points for more complete and searching experiments on technique. The one factor that is, however, virtually a closed book is moisture requirements for nurseries at various ages. This might well be of great importance and might interplay with other management methods. It would therefore be unsatisfactory to have experiments which did not take watering into consideration but without any basic information on soil moisture under tea it becomes virtually impossible to produce satisfactory experimental designs.

Therefore, instead of starting formal nursery experiments with the 1957 seed harvest, as originally intended, gypsum soil moisture blocks were sunk at various depths down to 7 feet under newly planted, 12- and 24-month-old nursery beds. Soil moisture readings are being taken at regular intervals and although it is far too early to draw definite conclusions it is already apparent that the unshaded oldest seedlings use soil moisture reserves at a rapid rate. There is a suggestion that the equivalent of one inch of rain will fill a one foot depth of soil from wilting point to field capacity, which if substantiated will form a useful yardstick for watering programmes. These observations will continue throughout the oncoming dry season and it should be possible to start formal experiments with the 1958 seed harvest.

In support of these soil moisture studies, root observations were made on the oldest seedlings by the usual root washing technique. Seedlings were at the orthodox spacing of 6 inches square in the nursery bed and there were no vacancies surrounding or in the washed out section. To a depth of about 18 inches below the surface there was a well developed tap root, typical of what is seen when a stump is uprooted before planting. However the undisturbed tap roots penetrated to a depth of between 5 and 6 feet, being about an eighth of an inch in diameter for most of their length. At the basal end they bore the usual cone of fine feeder roots. The top 18 inches of tap root bore few woody lateral branches and these were poorly developed because of the close competition between plants in the nursery bed. Fine feeder roots, produced in great density within the top foot to 18 inches of soil, became less dense though still very numerous in the deeper soil layers. The whole of the soil volume down to 5 feet below surface level was well colonized by fine feeder roots and root competition between bushes was complete and no doubt severe.

Establishing Tea

(i) ESTABLISHMENT EXPERIMENTS

This series of experiments was concluded during the 1955/56 season and the full results are to be published in *Tropical Agriculture* during 1957.

(ii) THE EFFECT OF SPACING ON THE SURVIVAL OF TRANSPLANTED TEA

The "Complex" Experiments, reported in more detail later, compare three spacings of tea:

4' x 4' square,
4' x 3' rectangular,
4' x (2' x 2') Hedge planting.

There are three complete replications of this experiment, the first being planted in December, 1952, the second a year later and the third two years later. A record has been taken in December each year of the number of deaths occurring in the previous twelve months by counting the number of replants and these are recorded in Table I.

TABLE I
Percentage of Replants according to Spacing and Age after Planting

Count taken at	Replication	Spacing	4' × 4'	4' × 3'	4 × (2' × 2')	L.S.D.	
		plants p.a.	2720	3630	7260	0.05	0.01
12 months after planting ..	First	no counts taken				—	—
	Second	3.4	2.7	2.8	none	—	
	Third	5.0	4.6	4.6	none	—	
24 months after planting ..	First	3.6	3.6	6.9	0.9	1.2	
	Second	1.4	1.6	2.6	0.6	0.9	
	Third	0.8	1.3	1.8	0.5	0.6	
36 months after planting ..	First	2.6	3.0	4.5	1.2	1.6	
	Second	0.8	0.7	1.7	0.6	0.7	

This table, similar to Table VII in last year's Report but with the addition of date for Replication 3 at 24 months and Replication 2 at 36 months, strengthens the conclusions previously drawn.

During the first twelve months after planting, closer spacing does not significantly increase the proportion of casualties.

Thereafter as competition between plants becomes more severe, closer spacing does directly influence the proportion of deaths, a result which emphasizes the necessity for attaining as high a stand as possible at first planting.

Increasing nitrogen rates, a second set of treatments in this experiment, have not significantly affected the proportion of deaths but it must be remembered that the total sulphur applied per plot has been equalized by the addition of flowers of sulphur as necessary. All experimental evidence suggests that it is the sulphur in fertilizers which is important in the early years and not the usual accepted nutrient supplied by the fertilizer.

The percentages of deaths added to the table for this season are low and are the result of good and well distributed rainfall for the previous twelve months.

(iii) EFFECT OF N.P. AND K. ON SURVIVAL

This experiment, planted at Mimosa in December, 1953, with stumps grown under experimental fertilizer treatments in the Swazi nurseries, compares the effects of the three major nutrients on the survival and growth of young tea. Full treatment details are described later in the section under FERTILIZER EXPERIMENTS, para 51.

Counts of deaths and replants have been taken according to treatments and are recorded as percentage deaths in Table II.

TABLE II
Percentage Deaths of newly planted and young Tea as affected by N.P. or K.

Date	S/Ammonia		Superphosphate		Muriate of potash		L.S.D.
	without	with	without	with	without	with	
December, 1953	—	—	Tea planted		—	—	—
May, 1954	5.0	4.3	4.1	5.2	4.7	4.6	none
December, 1954	6.0	4.8	5.6	5.2	5.0	5.8	none
December, 1955	2.6	1.9	1.7	2.8	2.1	2.4	none
December, 1956	1.5	1.5	1.5	1.5	1.6	1.4	none

At no time was survival significantly affected by fertilizer treatments although it is again necessary to record that sulphur was equalized over all plots by the addition of flowers of sulphur.

(iv) PRACTICAL IMPLICATIONS FOR FERTILIZING NEWLY PLANTED TEA

Throughout the past five years, observations and experimental results lead to the following practical recommendations for fertilizer applications to tea during the first twelve months following transplanting; the establishment period. Sulphur deficiency leading to the symptoms of 'Tea Yellows' occurs in sporadic and not easily predicted areas. It is more common in Mlanje than in Cholo but can easily be prevented in both districts by applications of sulphur and the most convenient way to do this is by applying sulphate of ammonia or complete fertilizer mixtures if these are favoured. In the Establishment Experiments *per se* little benefit was obtained from fertilizer applications either in survival or in early growth, provided sulphur deficiency symptoms did not develop in the unfertilized plots. When symptoms did develop the effects of fertilizer in both respects were highly significant.

Because potentially deficient areas cannot be conveniently predicted it appears to be prudent to apply fertilizer to all new plantings as a matter of routine and in good time to prevent symptoms occurring. Although the condition can be cured, if quick action is taken once symptoms appear, the tea bush inevitably suffers a detrimental and unnecessary delay which might well have a residual effect after the symptoms have disappeared.

Nitrogen, phosphate, or potash have not given significant responses during the establishment period in this country but it must be admitted that the range of experiment is not as wide as could be wished.

Consequently the recommendation is offered that one ounce of sulphate of ammonia per stump or one ounce of the common 15: 6: 3 mixture should be given one month after transplanting in the field from the nursery. The fertilizer should be near to the stump and buried well into the soil to avoid losses by surface wash.

Root Studies

(i) ROOT DEVELOPMENT IN NURSERIES

(See under NURSERY EXPERIMENTS.)

(ii) DEVELOPMENTS OF THE ROOT-SYSTEM, SWAZI

These studies on 4½ year old tea were continued in June, 1957. The tea is unshaded and grown from stumps planted at 4 feet square in the field. There is little new to add to last year's Report. The woody branching laterals in the top 3 feet of soil continue to develop in diameter. These bear a well developed branching system of

fine feeder roots which fully and densely exploit this soil volume. Root competition between plants in this depth is complete. Below and to a depth of 5 feet, permanent woody laterals are almost absent but fine feeder bearers arising from tap root branches and from the few woody lateral branches, are well evident though not as dense as in the top 3 feet. Fine feeders from these bearers were still sporadically evident down to 7 feet but were not traced below this depth. Tap root penetration in depth was variable, as noted in previous years' observations but in most cases they had penetrated to a depth of 6 or 7 feet. For the last foot of their length they bore either distinctly or less distinctly a cone of fine branches, bearing many fine feeders which in turn had penetrated to 7 or 8 feet. These studies will be continued for a period as it is evident that all bushes have now formed the basis of their mature rooting systems and these will merely develop steadily and slowly with time.

Soil Moisture Studies

(i) SOIL MOISTURE MOVEMENTS UNDER MATURE TEA, SWAZI

Of very great importance in the planning of management methods for tea in Nyasaland is the fear and effects of the protracted dry season. In essence those effects must be closely bound with soil moisture reserves, a subject not previously studied under Nyasaland conditions. In co-operation with the Agricultural Chemist, Lilongwe, a series of observations were started during this season, chief of which is a simple study of moisture reserves under pruned and unpruned tea.

An area of mature Indian tea, in its third year from prune was divided into three blocks and half of each block was pruned in May, 1956, at the beginning of the dry season. On the last day of April, 1957, the halves unpruned in 1956 were pruned. Thus at any one time half of each block was carrying pruned or unpruned tea. In each plot a set of gypsum blocks was placed at the following depths: six inches, one, two, three, four, five, six, eight and ten feet. Unfortunately, recording apparatus was delayed and not received until October, 1956; consequently drying out of the soils throughout the early part of the 1956 dry season could not be followed.

Precise constants are not fully worked out for the soils under examination and in the meantime measurements are recorded daily using a scale marked on the instrument as "Percentage Available Soil Moisture". These data might have to be transformed when moisture constants for this soil are eventually determined but in the meantime, and with some information available, it appears that the present calibration will not differ greatly from the precise scale to be ultimately adopted. From the cruder aspects of observing soil moisture changes in response to management method, the main aim from a practical tea-growing view-point, the percentage available moisture scale has proved adequate and informative (see Figure 1).

Data taken from 11th October, 1956 (the hot dry season) until 10th July, 1957 (midway through the cool dry season) is recorded graphically in Figure 1 wherein points shown are at weekly intervals and the values for two, four, five, seven and eight feet being excluded by lack of space. In actual fact the omitted data reflect smoothly the moisture changes above and below and their omission does not affect the general picture given by Figure 1.

In mid-October the soil under unpruned tea was considerably dried down to the maximum depth recorded, 10 feet. Drying out at depth continued until the break of the rains. At the start of the same period, soil moisture conservation can be observed under tea which had been pruned the previous May. As this tea recovered from prune and formed its new top hamper of leaf, the soil below was dried out in inverse proportion to depth. In mid-November and before the rains, a slight drying was recorded in even the 10 foot depth under pruned tea.

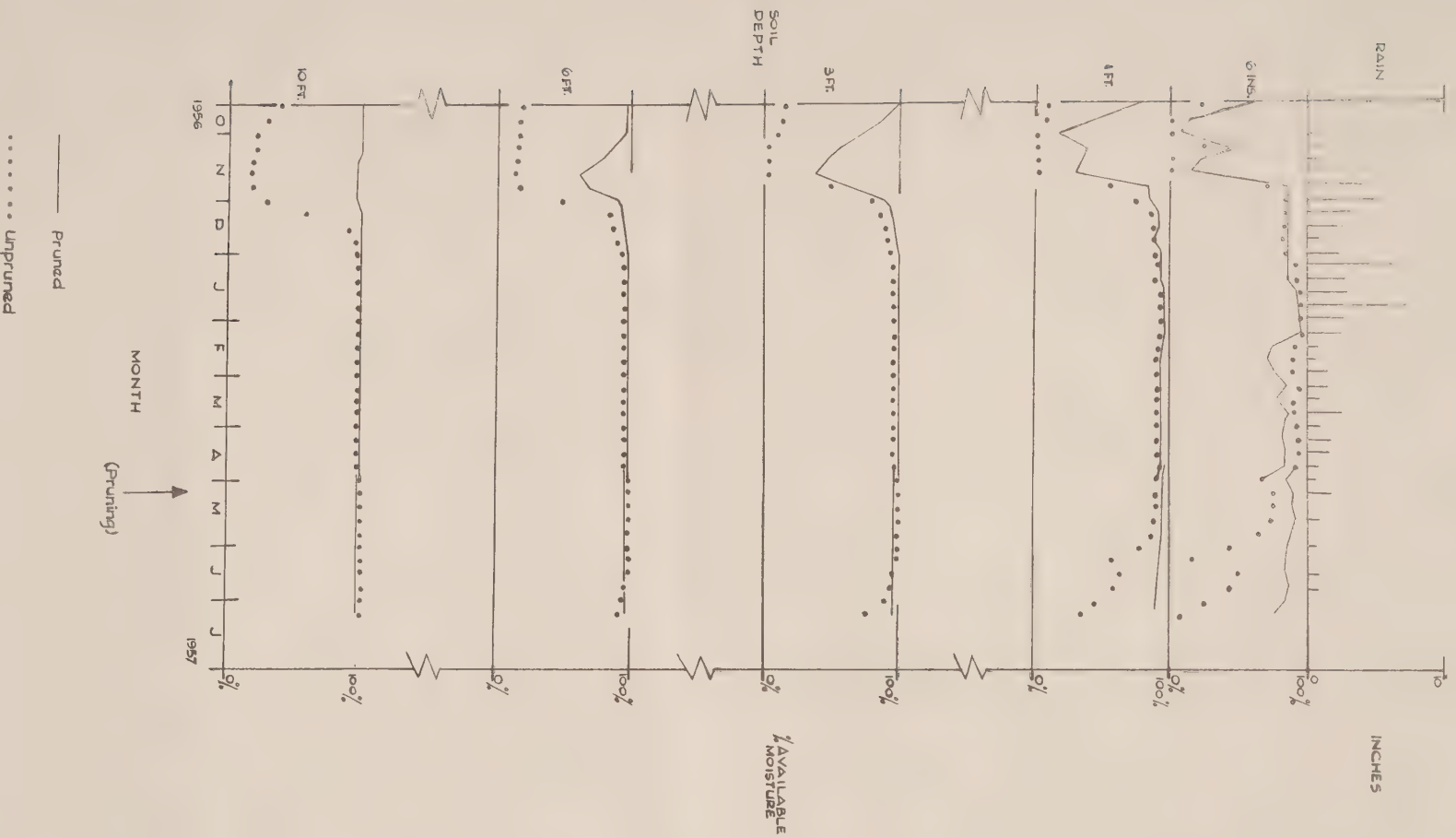
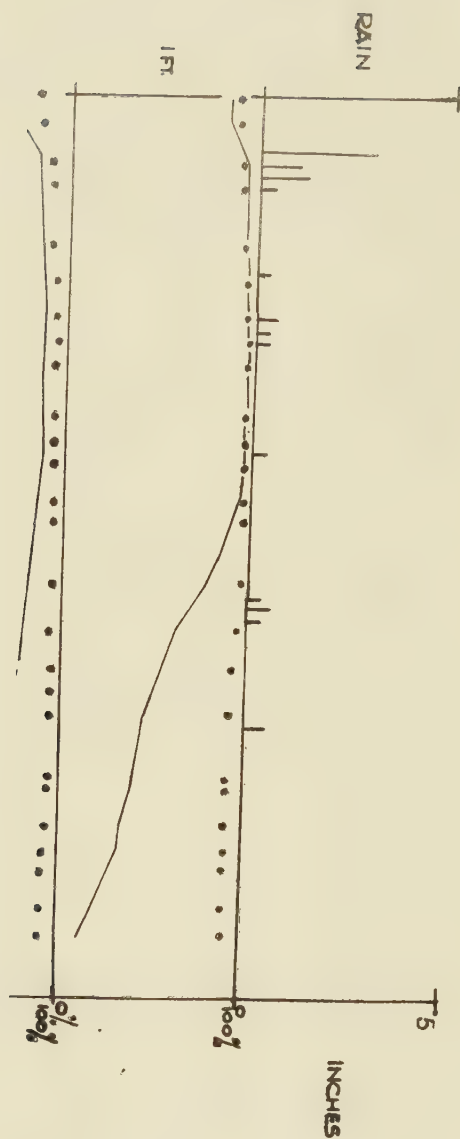


Fig 1. Soil moisture movements under pruned and unpruned
mat. 2 Tea at Swazi, 1956/57.



supplies evidence much of the destruction caused by cover crops received on young corn whenever they have been tried in Nyasaland.

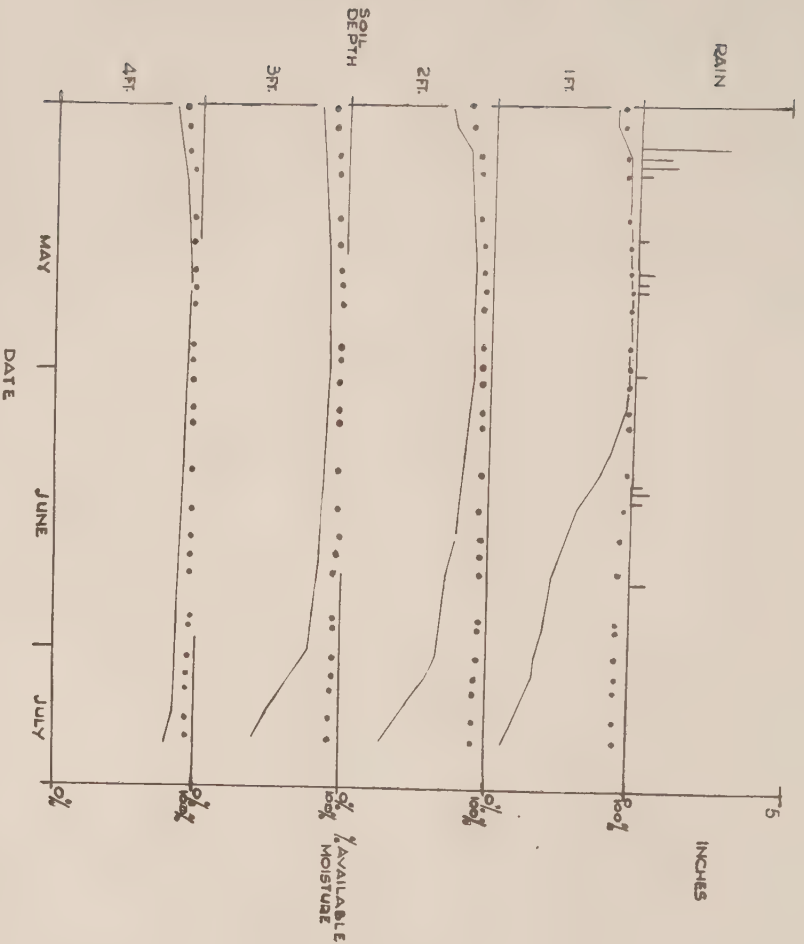


Fig 2. Soil moisture movement under Tea planted with and without cover crop *Stylosanthes gracilis*.

The rains broke in classic fashion on 15th November and were heavier than average until the end of January. All soil depths were well filled by the end of December, approximately six weeks after the start of the rainy season. From February onwards, rainfall was well below average but only the top foot of soil showed any marked degree of drying before the expected end of the rains in April. Thereafter and until the time of writing 10th July, 1957, soils under unpruned tea are showing obvious signs of drying and moisture conservation is again apparent under pruned tea. No technical comment on these data will be made until at least another season's records and exact constants are available.

Interesting and not unexpected observations with respect to management methods appear. Firstly, pruning conserves soil moisture if done early but to translate this observation into a case for annual pruning of mature tea is to disregard present experimental evidence which indicates, in Mlanje at least, no benefits from annual pruning and potentially large benefits from extended cycles (see the sections on PRUNING EXPERIMENTS in this and previous Annual Reports). This observation is supported by evidence from certain Cholo estates.

The benefits of early pruning, already known from empirical experience, receives a more fundamental backing. To delay pruning until July and later (as was the habit only two or three years ago) means that pruning is taking place on a dry soil with consequent delay in recovery, the danger of sunscorch to the unprotected framework at the end of the dry season, and a delay in crop after the main rains arrive. It is particularly important that heavy pruning be done early.

(ii) SOIL MOISTURE MOVEMENTS UNDER THE COVER CROP *STYLOSANTHES GRACILIS*

The deleterious effects of Fish Bean (*Tephrosia vogelii*) either on the survival of newly planted tea or on subsequent early growth have been recorded in the Establishments Experiments. Observations are being made upon the effects of *Stylosanthes gracilis* on young tea; this being a creeping cover crop as opposed to the upright tall bushy habit of *Tephrosia*. *Stylosanthes* grows very rapidly and prolifically in Nyasaland and it has to be continuously lopped and pulled back from the tea plant. Approximately twelve months after interplanting with the tea the latter was pruned and *Stylosanthes* has had a very deleterious effect on growth when judged by pruning weights.

Mean Pruning Weights per Row of Tea—Fresh Weights

With <i>Stylosanthes</i>	..	..	..	..	43 lb.
With no cover crop	..	..	..	..	97 lb.

Gypsum soil moisture blocks were sunk during the end of May, 1957, at the following depths below both treatments: 1 foot, 2 feet, 3 feet and 4 feet. Recordings are made using the "Percentage Available Soil Moisture" scale and readings at approximately weekly intervals are recorded in Figure 2.

Considerable drying can be observed in soils carrying *Stylosanthes* in comparison with soil carrying tea alone. Because the tea is newly pruned, moisture conservation is not unexpected in the no-cover crop plots. From July until the break of the new rains in November the expectation of rain is very poor, not less than 2 inches and not more than 6 inches. It appears therefore that the cover crop will seriously deplete the soil moisture reserves early in the dry season and consequently the young tea will be at a considerable disadvantage in comparison with its counterpart not in competition with *Stylosanthes*. It is possible that competition for soil moisture supplies explains much of the deleterious effects of cover crops recorded on young tea whenever they have been tried in Nyasaland.

(iii) SOIL MOISTURE MOVEMENTS UNDER SHADE TREES

Gypsum blocks have been sunk under various shade species but the readings obtained are inconsistent and it will be necessary to sink more replicates before conclusions can safely be drawn.

(iv) SOIL MOISTURE MOVEMENTS IN THE NURSERY

These newly started observations are reported briefly under the section on NURSERY EXPERIMENTS.

Pruning Experiments

(i) LENGTH OF PRUNING CYCLE AND TYPE OF PRUNE, SWAZI

This experiment started its sixth successive three-year cycle at the beginning of the season. All plots were pruned according to experimental treatments; the annual and two yearly cycle clean prune plots being rested until February, 1957, before being heavily down pruned to 10 inches.

(ii) PRUNING CYCLE ON LOCAL JAT TEA, THORNWOOD ESTATE

Three clean prune cycles are compared and form one set of treatments in this factorial experiment on old local jat tea. At the beginning of the season the annual and two yearly cycle plots were pruned, the three yearly plots beginning at the same time their second season from prune and hence were unpruned. Yields for the past season and total yields for the full five seasons, according to pruning treatments, are given in Table III.

TABLE III

Yields in lb. m.t.p.a. according to Pruning Cycles, Thornwood Local Experiment

Cycle						Yearly	2-yearly	3-yearly	L.S.D.	
									0.05	0.01
1956/57	..	..	..	..	..	1,029	1,305	1,125	196	none
Five seasons	..	..	..	..	..	5,549	5,432	5,535	none	none

During the past season the two yearly cycle (newly pruned) has significantly outyielded the annual cycle (newly pruned). Neither of these cycles are significantly different in yield from the three yearly cycle. (two years from prune.) There are no significant differences between pruning cycles for the total yield over five seasons which the experiment has run. Consequently no reliable amount of crop has been lost by extending the cycle beyond the yearly prune which is the most common cycle favoured for local tea.

Superimposed on this experiment are three rates of nitrogen application providing 40, 80, or 120 lb. of nitrogen per acre in the form of sulphate of ammonia. (Phosphate and potash dressings are equal over all plots.) There is no significant interaction between length of pruning cycle and nitrogen rates but it is possible that one might be building up. Table IV records total yields for the five seasons according to pruning cycle and nitrogen rates, and although the differences are not significant there appears to be a suggestion that nitrogen at 40 lb. per acre per year may not be sufficient to fully support extended cycles.

TABLE IV

Yield in lb. m.t.p.a. for Five Seasons according to Pruning Cycle and Nitrogen Rate,
Thornwood Local Experiment

Pruning cycle	Nitrogen, lb. p.a.		
	40	80	120
Yearly	4,514	5,437	6,697
Two yearly	4,219	5,408	6,670
Three yearly	3,999	5,623	6,984

Tipping Experiments

(i) HEIGHT OF TIPPING INDIAN JAT TEA, SWAZI

This experiment, comparing tipping heights at 4, 6 and 8 inches above the pruning cut on unshaded Indian jat tea, started a new three-year cycle at the beginning of the season. Yields in lbs. of made tea per acre for the tipping and table forming phase to the end of November and for the whole season are recorded in Table V.

TABLE V

Yields in lb. m.t.p.a. according to Tipping Height, Swazi

Tipping height					4"	6"	8"	L.S.D.
Tipping phase					371	310	276	P=0.05=38
Whole season					2,112	2,031	2,072	none

As in all tipping experiments carried out in recent years, significant amounts of crop have been lost during the tipping and table forming phase; thereafter, these losses do not persist with significant extent and whole season crops do not show significant differences caused by tipping height.

(ii) TIPPING LOCAL JAT TEA, THORNWOOD ESTATE

Superimposed on the three pruning cycles in the experiment on local jat tea are three tipping heights at 2, 4 and 6 inches above the pruning cut. There is a significant interaction between pruning cycle and tipping height ($P=0.05$) during the tipping phase but this is accounted for because within the pruning treatments the three-year cycle was unpruned at the beginning of the season and consequently untipped. Yields over the tipping phase to the end of November and for the whole season are recorded in Table VI.

TABLE VI

Yields in lb. m.t.p.a. according to Pruning Cycle and Tipping Height, Thornwood Estate

					Tipping phase			Whole season		
					2"	4"	6"	2"	4"	6"
Annual cycle					195	148	127	1,064	1,033	991
Two yearly cycle (pruned)					286	216	152	1,441	1,275	1,198
Three yearly cycle (unpruned)					162	188	201	1,073	1,111	1,193
Mean					214	185	160	1,193	1,140	1,126
L.S.D. Main effect tipping, $P=0.05=41$ Interaction, $P=0.05=72$								No significant effects for whole season		

Considering the main effects of tipping first, significant losses in crop due to raising the tipping height have only occurred over the tipping phase. These differences do not persist and are lost in the whole season yield. This is in repetition of previous experience.

When considering the different cycles over the tipping phase, the two newly pruned cycles showed losses due to increasing tipping heights. But the unpruned three-yearly cycle over this period (and over the whole season in fact) showed a gain in crop from the residual effects of increased heights applied during the 1955/56 season.

Fertilizer Experiments

This section will only deal with fertilizers applied to unshaded tea at one spacing in any one experiment. The interplay of fertilizers with spacing or with shade will be reported in later sections. Unless otherwise stated, experiments comparing the effects of only one fertilizer receive the two other fertilizers over all plots at equal rates.

(i) N.P.K. EXPERIMENT ON YOUNG INDIAN TEA, MIMOSA

This experiment was planted at Mimosa in December, 1953, and compares the effects of the three standard fertilizers upon the growth and yields of young tea. Fertilizer rates will increase yearly until stabilized after seven years. Table VII summarizes fertilizer treatments so far applied.

TABLE VII
Fertilizer Rates according to Age in lb. p.a. of N, P₂O₅ or K₂O

Date applied					Nutrient lb. p.a.					
					n ₀	n ₁	P ₀	P ₁	k ₀	k ₁
December, 1953	..	..	..	..	—	—	Tea planted		—	—
June, 1954	..	..	..	..	10	20	nil	10	nil	20
December, 1954	..	..	..	..	15	30	nil	10	nil	20
November, 1955	..	..	..	..	20	40	nil	15	nil	20
November, 1956	..	..	..	..	25	50	nil	20	nil	25

Sulphur has been equalized over all plots by the addition of flowers of sulphur as necessitated by the treatment combination. The fertilizers used are sulphate of ammonia, superphosphate and muriate of potash. To date this young tea has been pruned annually at the beginning of each dry season starting in 1955. Tipping has been high and plucking light. First yields were taken during the 1955/56 crop season and yields for that season and the past season are recorded in Table VIII.

TABLE VIII
Yields in lb. m.t.p.a. according to Fertilizer Treatments on young Indian Tea

Season		n ₀	n ₁	P ₀	P ₁	k ₀	k ₁	L.S.D.
1955/56	.. ..	253	264	258	259	262	255	none
1956/57	.. ..	630	651	625	656	648	633	none

There are no significant differences due to fertilizer treatments although it must be remembered that sulphur was adequate over all treatment combinations. Sulphur contents of sulphate of ammonia and superphosphate which might have had an effect otherwise are therefore masked.

It appears from these and allied experiments that either no responses or only small responses can be expected with young tea growing on virgin soils from the three major nutrients as such providing sulphur is adequate. As already stated in a previous section the most convenient way of applying sulphur is in the form of sulphate of ammonia or superphosphate.

(ii) SULPHATE OF AMMONIA AT FOUR RATES ON ELEVEN-YEAR-OLD INDIAN TEA, SWAZI

This experiment compares four sulphate of ammonia rates supplying the equivalent of 0, 80, 160 and 240 lb. of nitrogen per acre. The tea was in its third and last year from prune. Yields for the past season are recorded in Table IX.

TABLE IX

Effect of Increasing Sulphate of Ammonia Rates on the Yields of Eleven-year-old Tea

<i>Lb. N. p.a.</i>	0	80	160	240
Yield lb. m.t.p.a. 	1,196	1,888	2,069	2,160

L.S.D. $P=0.05 = 140$
 $P=0.01 = 194$
 $P=0.001 = 266.$

At $P=0.001$ all sulphate of ammonia rates have significantly outyielded the no fertilizer yields. At $P=0.01$ the highest rate of sulphate of ammonia has significantly outyielded N80 but there is no significant difference between it and N160. The responses in terms of lb. of made tea for each lbs. of added nitrogen are: for the first 80 lb. of nitrogen 8.65 lb. of tea, for the next 80 (N80 to N160) 2.26 lb. of tea and for the last 80 (N160 to N240) 1.14 lb. of tea. The response therefore falls off rapidly beyond N80. A response of over 8 lb. of made tea is good and reflects the good crop season. Responses of 2 lb. of tea and less are nevertheless of economic benefit. Five lb. of sulphate of ammonia (equivalent to 1 lb. of nitrogen) would be applied for approximately 1s-5d and the profit per lb. of made tea over the last season would have been in the region of one shilling.

(iii) SULPHATE OF AMMONIA AT FOUR RATES ON MATURE INDIAN TEA, SWAZI

This tea, 24 years old, and in its third and last year before pruning, received sulphate of ammonia supplying the equivalent of 35, 52, 70, and 120 lb. of nitrogen per acre. Prior to the 1954/55 season the N120 plots were unfertilized control plots and from then onwards the highest rate replaced the old treatment. This tea was heavily down pruned in March, 1956, consequently yields and responses are not as they might have appeared had a full crop season been recorded. Yields for the past season are recorded in Table X.

TABLE X

Effect of Four Sulphate of Ammonia Rates on the Yield of 24-year-old Tea

<i>Lb. N. p.a.</i>	35	52	70	120
Yield m.t.p.a. 	459	505	668	739

L.S.D. $P=0.05 = 82$
 $P=0.01 = 111$
 $P=0.001 = 150$

The two highest rates of nitrogen have significantly outyielded the two lower at $P=0.001$. There are no other significant differences. The return in lbs. of tea for each lb. of nitrogen added is 5.97 from N35 to N70 and 1.42 from N70 to N120. Recovery in yield of the unfertilized plots, after receiving the highest rate of nitrogen, has been spectacular as can be seen from Table XI.

TABLE XI

<i>Treatment</i>	<i>lb. m.t.p.a.</i>			<i>Yields as per cent. of n35</i>		
	n0	n35	n70	n0	n35	n70
1952/53	257	443	565	58	100	128
1953/54	134	247	337	54	100	136
<i>Treatment</i>	n120	n35	n70	n120	n35	n70
1954/55	767	818	1,006	94	100	123
1955/56	896	652	922	137	100	141
1956/57	739	459	668	161	100	146

The ultimate increments in yield up to 120 lb. of nitrogen per acre can be expected to be nearly linear for mature unshaded tea of this type and age. Consequently full recovery has not yet been achieved. The theoretical linear yields this season would have been 966 lb. m.t.p.a. or 211 per cent. in comparison with N35. As stated above the tea was subject to a heavy down prune during the main cropping season and the yields and responses are therefore low in comparison with whole season data from other experiments.

(iv) THREE-CUBED FACTORIAL N.P.K. ON MATURE INDIAN TEA, SWAZI (MLANJE)

This treatment received its sixth consecutive set of treatments during the past season and the tea, 25 years old, is poor Indian, spaced four feet square and unshaded. The following treatments are compared in factorial combinations

Sulphate of ammonia supplying .. 40, 80, or 120 lb. N. per acre
 Single superphosphate supplying .. 0, 30, or 60 lb. P_2O_5 per acre
 Muriate of potash supplying .. 0, 30, or 60 lb. K_2O per acre.

Yields for the past season are recorded in Table XII.

TABLE XII

Effect of N.P. and K. on Yields at Swazi, Yields in lb. m.t.p.a.

<i>Nutrient</i>	N			P_2O_5			K_2O		
<i>lb. p.a.</i>	40	80	120	0	30	60	0	30	60
Yield m.t.p.a.	1,104	1,414	1,670	1,379	1,388	1,421	1,402	1,403	1,383
L.S.D.	$P=0.001=200$			none			none		

Only nitrogen has had significant effects on yield and each upward step has caused highly reliable increases. The response to each lb. of added nitrogen is 7.75 lb. of tea from N40 to N80 and 6.40 lb. of tea from N80 to N120, a slight tailing off therefore towards the highest rate.

There are two complete replications in this experiment both of which have been down pruned. One replication was so treated before the beginning of the 1956/57 season and the second, a year previously. The appearance of the tea after this heavy prune is very good but full recovery has not yet been made. It is possible therefore that the bushes are not yet sufficiently big to make full use of the highest nitrogen rate resulting in a tailing off in response. Phosphate and potash have not given significant results; the former in spite of last year's optimism.

(v) THREE-CUBED N.P.K. ON MATURE INDIAN TEA AT NAMIREME ESTATE (CHOLO)

The treatments in this Cholo experiment are exactly similar to those described for Swazi. The tea was clean pruned at the beginning of the season and treatments were applied for the second consecutive year. Yields for the past season are recorded in Table XIII.

TABLE XIII

Effect of N.P.K. on Yields at Namireme Estate. Yields in lb. m.t.p.a.

Nutrient	N			P ₂ O ₅			K ₂ O		
lb. p.a.	40	80	120	0	30	60	0	30	60
Yield m.t.p.a.	457	556	661	560	554	560	547	561	566
L.S.D.	P=0.01=84			none			none		

Each upward step has caused significant increases in yield. The response from N40 is 2.48 lb. of made tea for each added lb. of nitrogen and from N80 to N120, 2.62 lb. of tea. These are very low in comparison with this season's responses in Mlanje but are supported by similarly low responses from a second Cholo N.P.K. fertilizer trial laid down on an estate where a potash deficiency was suspected. In this second experiment, receiving its first season of treatments, only nitrogen caused a significant response and yielded a return of 1.69 lb. of tea for each lb. added. This tea is very old, being widely spaced at about five feet square, and this might be expected to reduce the responses.

It has been suspected by the stations and by members of the Cholo community that lower nitrogen responses are obtained there than in Mlanje. These two experiments bear out this suspicion but it would be unwise to make further more definite comment on data which extends for only two seasons on the first experiment and for only one season on the second. There appeared to be a suspicion of a positive response to potash during the dry season at Namireme but this did not prove significant.

(vi) SULPHATE OF AMMONIA ON LOCAL JAT TEA, THORNWOOD ESTATE

Pruning cycle and tipping effects in this experiment have been discussed earlier. The third set of treatments compares sulphate of ammonia applications supplying three rates of nitrogen; 40, 80, and 120 lb. per acre. Significant increases in crop due to increasing nitrogen rates can be seen in Table XIV.

TABLE XIV

Effect on Yields of Increasing Nitrogen Rates at Thornwood Estate

lb. N. p.a.	40	80	120	L.S.D.
Yield	739	1,150	1,570	P=0.001=358

Averaged over all pruning and tipping treatments the return from N40 to N80 was 10.28 lb. of made tea for each added lb. of nitrogen and 10.53 lb. of tea from N80 to N120. These responses are linear up to the highest rate and are high, reflecting the good crop season. The effects of nitrogen upon the spread of the bush are visual and in commercial practice a considerable reduction in weeding costs could be expected from the high nitrogen applications.

This experiment has on a number of occasions yielded data which shows that the response to each lb. of nitrogen is higher from unpruned tea than from newly pruned tea. It will be remembered that the annual and two-yearly cycles were pruned at the start of this season and that the three-yearly cycle was unpruned and in its second year from prune. Table XV presents data which supports again the nitrogen response and pruning interplay.

TABLE XV
Response in lb. m.t. for each added lb. of Nitrogen, Thornwood

				From N40 to N80		From N80 to N120		Mean
Newly pruned	..	..	..	9.06	..	8.73	..	8.89
Unpruned	..	..	..	12.68	..	14.12	..	13.40
Mean of all cycles	..	..	..	10.28	..	10.53	..	—

Time of Fertilizer Application

(i) AT FOUR TIMES DURING THE MAIN CROPPING SEASON, SWAZI

This most informative experiment, after receiving for a number of seasons fertilizer applications in whole or split doses during the main cropping season, was modified this year and all fertilizer was applied to all plots during the first week of November. The tea was, however, heavily down-pruned during the main cropping season and yields are therefore foreshortened and low.

The past results from this early experiment, although being apparently logical and systematic have never proved statistically significant, primarily because a demonstrably bad field layout yields a coefficient of variation of about 30 per cent. (Most of the older experiments run in the vicinity of 10 per cent. and the newer ones show promise of obtaining standard error percentages of 7 or lower.) The differences in yields due to various times of fertilizer applications do, however, correlate closely with rainfall quantities falling after their application. It is thought, therefore, that added confidence in the time effects would be gained if, after applying fertilizer all at one time over all plots, the yield differences decreased to a noticeable degree. This trend appears to be happening but, as stated above, yields were cut short by pruning during the main crop season and definite conclusions cannot be made this season.

(ii) MID DRY SEASON AGAINST EARLY CROP SEASON DRESSINGS, SWAZI

This experiment, part of experiment (iii) reported under the section on FERTILIZERS, has for a number of seasons past demonstrated that sulphate of ammonia applied during the first week of July is significantly less efficient than equal doses applied during the first week of November. The differences have repeatedly been significant at $P=0.01$. In indirect support of the results described in the previous experiment, fertilizer was applied to all plots during the first week of November. Unfortunately, for this season's yields, the experiment had to be heavily down-pruned in mid crop season; residual effects are apparent and the previous July plots still yielded significantly less crop than the November ones but the width of the difference between yields appears to be narrowing and the level of significance has dropped to $P=0.05$. For both of the above experiments it would be unwise to draw more definite conclusions until more data are available.

(iii) THREE TIMES OF APPLICATION, SWAZI

Superimposed on the three tipping heights at Swazi are three times of fertilizer application. No significant differences resulted this season from time of fertilizer application but the results support the contention that early November is the most efficient date.

TABLE XVI

Effect of applying Fertilizer in early September, November or January

<i>Application during the first week of</i>					<i>Percentage crop</i>
September	..	..	..	..	97.1
November	..	..	..	..	100.0
January	..	..	..	..	96.9

Weeds and Weeding

(i) WEED KILLERS, INTRODUCTION

Observational work with chemical weed killers was continued during the season. Most of the observations were confined to the use either singly or in combination of the following chemicals:—

- (a) T.C.A.
- (b) 2.4D.
- (c) M.C.P.A.
- (d) P.C.P.
- (e) Dowpon
- (f) Sodium Chlorate.

In these early observations emphasis was placed more upon the effects of weed killers on the tea and weeds rather than upon financial considerations.

A brief summary of the observed effects of each of these chemicals is given below:—

(ii) T.C.A.

Initially an attempt was made to obtain an effective kill of established weeds (particularly grasses) in tea at various stages of development and concentrations of from 15 lb. up to 100 lb. per acre were applied during the early rains in November and December. It was observed that an application of at least 50 lb. per acre was required to obtain any effective control of the grasses and nearly always such an application seemed to affect the normal growth of the tea, especially in the following dry season. Newly-planted tea stumps often produced distorted shoots, and tea from 15 months up to three years from planting showed severe scorching of foliage leading to death in some cases.

The original hope of obtaining complete control of semi-mature to mature weeds was therefore abandoned. In its place an attempt was made to check weed growth over the early stages of the rains when labour for hand weeding is chronically short. If weeds can be checked over this period then much good will result, especially in young tea clearings. Thereafter labour is usually returning in numbers sufficient for estates to begin hand weeding.

T.C.A. at various concentrations was therefore applied as a pre-emergence spray on 9th October, 1956, after a fall of 0.48 inches of rain, and post-emergence spraying was carried out on 29th October when weeds and grasses were about 3 inches high.

Post-emergence sprays with T.C.A. alone were always more effective than pre-emergence sprays in controlling grasses. An application of 20 lb. T.C.A. per acre as a pre-emergence spray gave fair control of grasses for six to eight weeks. The same rate applied as a post-emergence spray produced a more complete and longer lasting control. No detrimental effect on the tea was observed. A reduction of the rate per acre to 15 lb. produced a similar effect with a slight loss of control in the pre-emergence spray. On the whole, broad-leaved weeds are little affected by T.C.A. up to 20 lb. per acre.

(iii) 2.4D.

This chemical used at a dosage rate of one pint per acre as a post-emergence spray gave effective control of most broad-leaved weeds, but also seemed to affect the tea adversely especially in the dry season. This adverse affect seemed to disappear with the onset of the rains.

(iv) M.C.P.A.

At a dosage rate of 2 pints per acre M.C.P.A. gave results similar to 2.4D.

(v) P.C.P. (15 per cent.)

At a dosage rate of $2\frac{1}{2}$ gallons per acre post-emergence spray, P.C.P. gave a distinct check all to types of grasses and other weeds but the effect was of short duration. The tea appeared to be unaffected.

(vi) DOWPON

This chemical was applied as a post-emergence spray at rates of 5 and 10 lb. per acre. A good control of grasses was obtained at the heavier application, but a marked scorching of the tea foliage, especially on hybrid types, was observed.

(vii) SODIUM CHLORATE

As a post-emergence spray at 20 lb. per acre (the only rate applied) Sodium Chlorate produced no noticeable effect on either weeds or tea.

(viii) T.C.A. IN COMBINATION WITH OTHER CHEMICALS

(a) T.C.A. + 2.4D.

The addition of one pint 2.4D to 20 lb. T.C.A. per acre applied as a post-emergence spray gave a wider control of all weeds, and a better kill of some grasses was obtained, particularly Chingombe (*Eleusine indica*).

(b) T.C.A. + M.C.P.A.

The addition of 2 pints M.C.P.A. to 20 lb. T.C.A. per acre produced a slightly better effect than T.C.A. + 2.4D noted above.

(c) T.C.A. + P.C.P. (15 per cent.)

The addition of 3 pints P.C.P. to 20 lb. T.C.A. per acre as a post-emergence spray gave a control of weeds only slightly better than T.C.A. alone, and the effect was of short duration.

(d) T.C.A. + DIELDRIN

In a comparison, using T.C.A. at 15 lb., 20 lb. and 30 lb. per acre, in an area of newly-planted tea stumps, Dieldrin at 1 lb. per acre was added to the weed killer. Percentage of deaths was not apparently increased by the treatments and no weeding was necessary for two months after spraying. Dieldrin offered good protection against termites and it was noticeable that dead stumps in these plots were not attacked by termites for as long as 107 days after planting.

(ix) Only tentative conclusions can be drawn from these simple observation trials, and they cannot be regarded as having provided any final information on the use of chemical weed killers in tea. They have, however, yielded three useful points. Firstly, that there appears to be a fair prospect of using carefully selected weedicides under Nyasaland conditions without harming the tea. Secondly, that the aim should be, at this stage of our knowledge, to provide a check to weed growth, particularly in young tea, during the rush months of November, December and January when labour is barely adequate for harvesting the crop. Finally, post-emergence spraying appears to offer the best chance of achieving this objective.

The ultimate assessment of the benefits or otherwise of weed killers must be made on the economics of the process, and sufficient experience and confidence in their use has been obtained to allow a long-term formal experiment to be started in the 1957/58 planting season.

Our appreciation and thanks are offered to those manufacturers and agents who have helped with equipment and materials.

In conclusion, a warning must be given that chemical weed killers should not be used indiscriminately in tea until conclusive experimental information on their safe use is available.

Spacing of Tea

(i) FOUR SPACINGS AND FOUR RATES OF SULPHATE OF AMMONIA, MIMOSA

In this experiment planted in 1951 and 1952, four spacings and four sulphate of ammonia rates are compared in all possible combinations. Treatment details applicable to the third season yields are listed below, the tea at the beginning of recording being equivalent to four-and-half years old from planting in the field. Sulphur was equalized over all plots.

<i>Spacings</i>				<i>Nitrogen p.a. rates</i>			
4' × 4' square	..	..	..	..	40 lb. N.p.a. as S/Am.		
4' × 3' rectangular	..	..	..	..	80 "	" "	" "
5' × (2½' × 2½') hedge	..	..	..	..	160 "	" "	" "
4' × (2' × 2') hedge	..	..	..	..	240 "	" "	" "

The main effects of nitrogen rates upon the past season's yields are listed in Table XVII.

TABLE XVII

Effect of increasing Nitrogen Rates on the Yields of Tea Four-and-a-half years old

<i>N. p.a.</i>	40	80	160	240	L.S.D.
Yields lb. m.t.p.a.	1,103	1,127	1,148	1,145	P=0.05=72

There are no significant differences due to nitrogen applications and is a result agreeing with other experimental evidence which shows that young tea cannot efficiently utilize high quantities of nitrogen. The results shown in Table XVII are taken from tea with an average stand of 4,560 plants per acre (approximately equivalent to a 5' × (2½' × 2½') hedge spacing). Spacing effects have, however, caused significant increases in yield as can be seen from Table XVIII.

TABLE XVIII

Effects of Spacing on the Yield per Acre of Four-and-a-half Year Old Tea

Spacing	4'×4'	4'×3'	5'×(2½'×2½')	4'(2'×2')
Yield lb. m.t. p.a.	977	1,101	1,142	1,302

L.S.D. $P=0.05=72$
 $P=0.01=98$

The 4'×(2'×2') hedge planted tea has significantly outyielded the 5'×(2½'×2½') and the 4'×3' spaced tea, which in turn have significantly outyielded the orthodox 4'×4' spacing. There are no significant differences between the medium two spacings. This repeats previous results. Over all spacing effects the average nitrogen application was 130 lb. per acre. There is no significant interaction between spacing and nitrogen rates.

(ii) "COMPLEX" EXPERIMENT, MIMOSA

This experiment, called for brevity, the "Complex", has been planted in three phases. There are three complete replications and each was planted in successive years starting at December, 1952.

The design of each replication is a "three-to-fourth" factorial and the present intention is to compare at maturity the following groups of treatments;

- Three spacings.
- Three nitrogen rates.
- Three lengths of pruning cycle.
- Three times of pruning.

At present only spacings and nitrogen rates are in operation. Spacings are:

- 4'×4' square equalling 2,720 bushes per acre,
- 4'×3' rectangular equalling 3,630 bushes per acre,
- 4'×(2'×2') hedge planted equalling 7,260 bushes per acre.

Nitrogen rates per acre are:

First year	..	..	..	10	..	20	..	30
2nd year	..	..	..	20	..	40	..	60
3rd year	..	..	..	30	..	60	..	90
4th year	..	..	..	40	..	80	..	120
5th year	..	..	..	40	..	80	..	120

Thereafter to continue as for fifth year.

Various measurements are made on these experiments in support of leaf yields. For example survival counts have been recorded in Table I. At each prune, weights of fresh prunings are taken and Table XIX records the mean bush yields as affected by treatments and age.

TABLE XIX

Fresh Pruning Weights per Bush according to Spacing from the "Complex" Experiments

(a) First Prune at approximately 18 months after Planting

Replication				Planted	Spacing			L.S.D.	
					4'×4'	4'×3'	4'×(2'×2')	P=0.05	P=0.01
First	..	..	..	Dec., 1952	0.86	0.78	0.47	0.13	0.17
Second	..	..	..	Dec., 1953	0.82	0.77	0.55	0.07	0.10
Third	..	..	..	Nov., 1954	1.23	0.96	0.54	0.17	0.23

(b) Second Prune at approximately 30 Months after Planting

Replication				Planted	Spacing			L.S.D.	
					4' / 4'	4' / 3'	4' / (2' / 2')	P=0.05	P=0.01
First	..	..	..	Dec., 1952	1.08	0.92	0.55	0.09	0.12
Second	..	..	..	Dec., 1953	1.09	0.86	0.57	0.09	0.12
Third	..	..	..	Nov., 1954	1.24	1.00	0.78	0.12	0.16

(c) Third Prune at approximately 42 Months after Planting

Replication				Planted	Spacing			L.S.D.	
					4' / 4'	4' / 3'	4' / (2' / 2')	P=0.05	P=0.01
First	..	..	..	Dec., 1952	1.26	1.00	0.56	0.10	0.13
Second	..	..	..	Dec., 1953	1.64	1.41	0.85	0.16	0.22

Inferred from these data inter-bush competition sets in during the first 18 months following planting. Pruning weight taken at first prune are the first weight recording taken, picking just follow this prune. Nitrogen has not significantly affected pruning weight in any replication or in any season. Yields of made tea according to spacing and age from planting are recorded in Table XX.

TABLE XX

Yields in lb. m.t.p.a. according to Spacing from the "Complex" Experiments

a) Yields taken between 18 and 30 Months after Planting, following First Prune and before Second Prune

Replication				Planted	Spacing			L.S.D.	
					4' / 4'	4' / 3'	4' / (2' / 2')	P=0.01	
First	..	..	..	Dec., 1952	108	124	158	13	
Second	..	..	..	Dec., 1953	369	439	583	40	
Third	..	..	..	Nov., 1954	228	266	365	27	

b) Yields taken between 30 and 42 Months after Planting, following Second Prune and before Third Prune

Replication				Planted	Spacing			L.S.D.	
					4' / 4'	4' / 3'	4' / (2' / 2')	P=0.01	
First	..	..	..	Dec., 1952	541	655	806	43	
Second	..	..	..	Dec., 1953	668	764	949	44	

(c) Yields taken between 42 and 54 Months, following Third Prune and before the Fourth Prune

Replication				Planted	Spacing			L.S.D.	
					4' / 4'	4' / 3'	4' / (2' / 2')	P=0.01	
First	..	..	..	Dec., 1952	1,116	1,288	1,646	79	

Each upward step in spacing over these early years has caused significant increases in leaf yields. The proportionate increases in yields due to spacing have remained fairly constant over these early years and can be seen in Table XXI wherein yields are totalled over all replications for each age group and are expressed as percentages of the orthodox 4' x 4' square spacing.

TABLE XXI
Proportionate Increases in Yield due to Spacing Effects expressed as Percentages of 4' x 4' square

<i>Plucking season</i>					<i>Spacing</i>		
					4' x 4'	4' x 3'	4' x (2' x 2')
First	..	..	..	..	100.0	117.6	156.9
Second	..	..	..	..	100.0	117.4	145.2
Third	..	..	..	..	100.0	115.4	147.5

From these data it is clear that the effects of spacing are not in simple direct proportion to the numbers of plants per acre because 4' x 3' rectangular spacing has 33.3 per cent. more plants per acre than 4' x 4' square and 4' x (2' x 2') hedge planting some 166.7 per cent. more plants. The relationship is well described by exponential functions. (Confirmation of these proportions is obtained from similar data extracted from the 'four-squared', spacings times Nitrogen Experiment.)

Nitrogen effects are listed in Table XXII.

TABLE XXII
Yields in lb. m.t.p.a. according to Nitrogen Rates per Acre from the "Complex" Experiments

(a) *Yields taken between 18 Months and 30 Months after Planting, following First Prune and before Second Prune*

<i>Replication</i>				<i>Planted</i>	<i>Nitrogen rate p.a.</i>			L.S.D.
					30	60	90	P=0.05
First	..	..	..	Dec., 1952	123	132	134	10
Second	..	..	..	Dec., 1953	443	472	475	30
Third	..	..	..	Nov., 1954	282	285	292	none

(b) *Yields taken between 30 Months and 42 Months after Planting, following Second Prune and before Third Prune*

<i>Replication</i>				<i>Planted</i>	<i>Nitrogen rate p.a.</i>			L.S.D.
					40	80	120	P=0.05
First	..	..	..	Dec., 1952	642	676	684	32
Second	..	..	..	Dec., 1953	791	796	795	none

(c) *Yields taken between 42 and 54 Months after Planting, following Third Prune and before the Fourth Prune*

<i>Replication</i>				<i>Planted</i>	<i>Nitrogen rate p.a.</i>			<i>L.S.D.</i>	
					40	80	120	P=0.05	P=0.01
First	..	..	..	Dec., 1952	1,306	1,358	1,386	59	79

The increases in yield due to nitrogen have not consistently reached significance between replications, and in the first two plucking seasons where significant differences do exist they are usually little more than the minimum requirement. The responses obtained for each lb. of nitrogen added when summarized over all replications is detailed in Table XXIII.

TABLE XXIII
Average Return in lb. m.t. for each lb. of Nitrogen added in the "Complex" Experiment

<i>Plucking season</i>				<i>lb. N. from</i>	<i>Response lb. m.t.</i>
First	..	..	..	30 to 60	0.46
				60 to 90	0.12
Second	..	..	..	40 to 80	0.49
				80 to 120	0.09
Third	..	..	..	40 to 80	1.30
				80 to 120	0.70

It is very doubtful if any of these responses are economically worthwhile. There are no significant interactions between spacing and nitrogen rates.

Permanent Shading of Mature Tea

(i) SHADE TREES AND N.P.K., MIMOSA

This formal experiment at Mimosa has been considerably enlarged in scope during the season. Four shade treatments form the main treatments and by suitably splitting these plots it has been possible to include four rates of nitrogen and two rates each of phosphate and potash in factorial combination under each shade treatment. Preparation and criticism of the experimental design unavoidably delayed fertilizer applications until early January, 1957. It will be possible to assess not only the relative merits of the shade species as such, but also the effects of the three common fertilizers separately and in combination under these species.

There were no significant differences due to fertilizers this season and that is not unexpected because the tea is still immature and has received in the past full fertilizer mixtures equally over all plots. Shade treatments have had significant effects as can be seen from Table XXIV.

TABLE XXIV
Effect of Shade Trees on Yields in lb. m.t.p.a.

<i>Shade</i>				<i>Gliricidia</i>	<i>Albizzia</i>	<i>None</i>	<i>Grevillea</i>
Yield	..	..	..	821	898	947	968

L.S.D. $P=0.05=48$
 $P=0.01=75$

At $P=0.05$, *Grevillea* and no shade have significantly outyielded *Albizzia* which in turn has significantly outyielded *Gliricidia*. There are no significant differences between *Grevillea* and no shade. The most pronounced difference is the depressing effect on yields of *Gliricidia*. The tea and the shade trees are very young as yet and there is no further comment that can be added at this stage.

Soil moisture measurements are being made under the shade species but results are perplexingly inconsistent and more replications are desirable before conclusions can be drawn.

(ii) OBSERVATION PLOTS, SWAZI

Records continue to be taken from observation plots shaded with *Albizzia gummifera*. Half of each plot receives no nitrogen and the remaining half, sulphate of ammonia supplying 80 lb of nitrogen per acre. Yields for the past season are recorded in Table XXV.

TABLE XXV
Yields in lb. m.t.p.a. from Shade and No-shade Plots

					Without shade		With shade		Mean for nitrogen
Without nitrogen	..	..	..	..	892	..	970	..	931
With nitrogen	..	..	..	..	1,477	..	1,281	..	1,379
Mean for shade	..	..	..	..	1,184	..	1,125	..	1,155

For the second year in succession shade when considered as a main effect has not had a pronounced positive effect on yields. This is perplexing. For the five seasons before 1955/56, shade invariably had a definite beneficial effect and over those seasons it increased yields by about one-third. No explanation can be given for this sudden loss of the clear-cut and beneficial effect of shade but it is of interest to note that it began immediately after the tea was heavily down-pruned two seasons ago. Whether the effects of the down prune are responsible or not is unknown and more data will be required before conclusions can be drawn.

The body of Table XXV offers interesting data. Shade without nitrogen has increased yields over the unshaded no-nitrogen plots. Under shade nitrogen has been less effective than on unshaded tea. The suppressing effect of shade on nitrogen has been recorded before. The response to each pound of nitrogen from unshaded tea was 7.3 lb. of tea but under shade it was only 3.9 lb. of tea. It is of interest to record that in the three-cubed N.P.K. at Swazi the response to nitrogen from adjacent similar unshaded tea, similarly pruned, was 7.6 lb. of made tea for each lb. of added nitrogen.

Vegetative Propagation

Investigations to discover a suitable technique for the vegetative propagation of tea have been made, during the past 25 years, in various countries but often the results published by one research-worker have been contradicted by another. In view of these contradictions and the climatic differences between Nyasaland and the other research stations, it was decided to investigate the problem from basic principles.

The rooting capacity of cuttings seems to be a clonal characteristic, some clones being extremely difficult to root. In these early experiments the parent material was taken from vegetatively produced plants, thus the clones which are very difficult to root have been avoided.

Throughout the experiments two approaches to vegetative propagation have been borne in mind:

(i) Ultimately the use of vegetatively produced material for large-scale field plantings, needing a cheap and simple technique.

(ii) The propagation of material for use in seed gardens (either for commercial seed production or for controlled breeding purposes) where a more complex and costly technique can be justified to ensure success.

TABLE XXVI

Percentage Survival of Cuttings in Relation to Wood and Bud States

Bud state	Cuttings planted				Per cent. survived			
	Wood state				Wood state			
	<i>t</i>	<i>m</i>	<i>b</i>	Total	<i>t</i>	<i>m</i>	<i>b</i>	Total
<i>d</i>	418	746	438	1,602	27	49	43	41
<i>s</i>	138	294	181	613	36	54	49	48
<i>e</i>	173	238	75	486	51	53	53	52
<i>c/a</i>	11	38	60	109	64	37	12	26
TOTAL ..	740	1,316	754	2,810	35	50	43	44

There seemed to be little difference caused by wood state, although the middle wood (*m*) was slightly better than the base wood (*b*), which in turn was better than the soft top wood (*t*). It may be deduced that under the conditions experienced and culture used that all wood up to twelve months should be used. The elongated buds (*e*) were found to be slightly better than the swollen buds (*s*) and both were found to be better than the dormant buds (*d*). All these types were considerably better than where the shoot was removed (*c/a*); it should be noted that this last state (*c/a*) was a very small sample of the whole.

The experiment shows that the material for cuttings should be used before the axillary shoots grow, or left until these shoots have themselves grown sufficiently to be used as cuttings, and that the other bud states have little effect on rooting.

(iii) TO INVESTIGATE OPTIMUM PERIOD FOR TAKING HALF-RIPE STEM CUTTINGS

Propagation of plants is usually affected by a time factor, which may be related to either the state of the plant and/or environmental conditions. This experiment was intended to investigate any such factor as applicable to tea in Nyasaland. The cuttings were planted during three periods.

- (i) after the main rains (April–May)
- (ii) during the dry season (July–August)
- (iii) during the rainy season (December–January).

Results are given in Table XXVII below.

TABLE XXVII

The Percentage Survival of Cuttings planted during various Periods of the Year

Planting period					Cuttings	Per cent. survival
April–May	..	..	..	..	831	49
July–August	..	..	..	..	931	58
December–January	..	..	..	..	648	12
TOTAL	..	..	..	..	2,410	43

The results show a definite depression of survival when cuttings were planted during the rainy season. This depression is thought to be due to excess water in the medium and actual physical damage to the leaves, coupled with mud being splashed over the leaf surfaces which may also form a seal over the axillary buds.

The results which follow are drawn from one year's work of an initial investigation in technique and as there were no formal experiments it was decided to ignore differences of less than 10 per cent. unless other reasons are stated. The end point of the cuttings experiments was survival, i.e. the leaf and bud remaining green and turgid, after a stated period. It is now thought that the production of a shoot would be a better criterion as this usually indicates that roots have been produced.

The report on vegetative propagation which follows is grouped under the four main headings of:—

Stem Cuttings out-of-doors,
Stem Cuttings in Cold Frames,
Air Layering, and
Pot Experiments.

STEM CUTTINGS OUT-OF-DOORS

(i) INTRODUCTION

The material used throughout these experiments was taken from stock plants of several clones planted in 1950/51. These plants had been planted at 6" × 6" in nursery beds and left untended since 1951. They were cut back to 18 inches in January, 1955, and new growth with red bark at the base was available by May. This state of growth is recommended for use as cuttings by several of the tea research stations. The material used was never more than twelve months old. The rooting medium was nursery soil.

Beds 3 feet 6 inches wide, raised 6-9 inches and with a slight surface slope to assist drainage, were prepared about a month before use. All beds were thoroughly firmed with open fingers as soon as they were prepared, and at all times a board was used when it became essential to stand on the beds. The cuttings were prepared by clean razor cuts and snags were kept to a minimum. Whilst preparing and planting the cuttings every attempt was made to prevent direct sunlight reaching either the cuttings or severed parent material. All cuttings were planted with a dibber and were not pushed into the medium. Usually the cuttings were planted so that the lower leaf was about half inch above the medium and the stem vertical. Exceptions are stated. After planting they were firmed and watered. Sufficient water is given to keep the soil in a friable ball state of dampness. Survival, expressed as a percentage of the cuttings planted, was recorded four months from planting. Other details of culture are given with each experiment.

(ii) THE EFFECT OF WOOD AND BUD STATES ON THE SURVIVAL OF HALF-RIPE STEM CUTTINGS IN THE OPEN

As a shoot grows it becomes lignified and the leaves become hardened. This experiment was intended to show the effect of age on the survival of cuttings. Bud development and root production are both thought to be connected with growth substance concentrations and the experiment was intended to investigate also the effect of bud state on the survival of cuttings. Results are shown in Table XXVI the three ages of wood being designated:—

t = the soft unhardened top wood but NOT the apical two leaves and bud which were discarded.

m = the middle wood, which is firm and has green or mottled bark.

b = the base wood, lignified and brown barked.

and the three bud conditions as:—

d = a dormant axillary bud.

s = a swollen axillary bud.

e = an elongated axillary bud.

c/a = an axillary shoot which has been cut back to its base.

(iv) A COMPARISON OF THREE TYPES OF HALF-RIPE INTERNODAL STEM CUTTINGS

Trouble caused by mud splash is described in para. 121 and this experiment compares taller cuttings well clear of the medium, with the types near the medium surface. The three types of cuttings used were:

- (1) Single leafed single internodal cutting
- (2) Double leafed (i.e. two internodes) cutting
- (2-1) Two internodes with only the upper leaf and bud left attached.

The single internodal cutting (1) was planted so as to leave a finger's breadth between the medium and leaf blade. A similar space was left between the medium and the lower leaf of the double leafed cutting (2). The third type of cutting (2-1) was planted so that the lower node—devoid of leaf and bud—was just below the medium surface. The double-leafed cuttings (2) were higher and had more food reserves than the single-leafed cuttings (1) but transpiration was expected to be greater. To overcome this source of moisture loss the third type of cutting (2-1) which was higher and yet contained negligible extra food reserves or transpiratory organs was used. Results are given in Table XXVIII below.

TABLE XXVIII
The Percentage Survival of Three Types of Half-ripe Internodal Stem

<i>Type of cutting</i>					<i>Cuttings planted</i>	<i>Per cent. survival</i>
Single internode	(1)	..	..	..	675	45
Double internode—						
(two leaves)	(2)	..	..	..	660	38
Double internode—						
(one leaf)	(2-1)	..	..	..	675	36
TOTAL					2,010	39

The table shows a result slightly in favour of the single internode type of cuttings (1), and when it is borne in mind that the other two types of cutting both use twice as much material, the single internode type is especially advantageous if the material to be propagated is in short supply.

(v) SHADE EXPERIMENTS

(a) *Introduction*

For photosynthesis there is an optimum light intensity which varies as other environmental factors vary. Light also heats the plant and in excess can cause scorch, but by adequate transpiration the leaves are cooled to approximately the temperature of the air surrounding them. An unrooted cutting is able to absorb only limited quantities of water through the stem and if the rate of transpiration exceeds the rate of absorption then dehydration can lead to wilting of the leaf and speedy death of the cutting. It is essential that a cutting be kept cool and the present method of doing this is to use shade. These experiments were intended to find the optimum shade which would allow the maximum light intensity without causing damage to the cutting.

(b) *A Comparison of Shades: High (6 foot) plus Low (1 foot) Shades with High Shade alone.* (The high shade was made from reeds and the low shade from grass.)

The amount of light passing through the high plus the low shades was less than through the high shade alone but it is thought that damage and splash, caused by rain-drops falling from the high shade, was reduced when their fall was broken by the additional low shade below. Single internode cuttings of one clone were planted at spacings of 3"×3" triangular and 6"×6" square in July. Half the cuttings at each spacing had high plus low shade, and the other half had high shade only. Results are given in Table XXIX below.

TABLE XXIX

Shade				Approx. per cent. full light	Cuttings planted	Per cent. survival		Mean shades
						3" × 3"	6" × 6"	
High + low shade	..	..		0.2	40 + 40	57.5	77.5	62
High shade alone	..	..		3.3	40 + 40	87.5	80	84
Mean spacings	..	..	..	—	—	72.5	79	76

The table shows there is a slight benefit by not using the low shade, but it must be remembered that the observations were made during the dry season when damage from falling rain drops and erosion is not great.

(c) *A Comparison of Shades: as in (b) But with a No Shade Treatment*

The three treatments were, no shade, high (6-foot) shade, and high (6-foot) plus low (1-foot) shade. Cuttings were planted at 3" × 3" triangular spacing, during May. Results are given in Table XXX.

TABLE XXX

The Percentage Survival of Cuttings planted under Three Shade Treatments

Treatment					Approx. per cent. of full light	Cuttings planted	Per cent. survival
No shade	(0)	..	..	..	100%	15	0
High shade	(1)	..	..	..	3.3	15	67
High plus low shade	(2)	..	..	..	0.2	15	28
TOTAL					—	45	31

Thus high shade alone (1) was better than high plus low shade (2) and both shade regimes were much better than the no shade (0) treatment where all the cuttings died within two weeks of planting. The high plus low shade would seem to be excessive, if cuttings are planted in the dry season.

(d) *A Comparison of Shades: Woven Bamboo Laths compared with High Reed Shade*

The use of bamboo lath shades was developed, and is practised, in Assam. Bamboo was cut into laths, about 1 foot wide and 1/10 inch thick. These laths were loosely woven to form a 4' × 4' square mat. The woven laths were supported on brick over prepared beds, there being 3 inches of space between each brick and about 4½ feet of space between the medium and the shade. It was desired to observe if the lath shade overcame rain-drop damage and splash without reducing the light to the extent of the low grass shade. Single internodal cuttings from one clone were used, and half of each treatment was exposed to direct sunlight before planting. The cuttings were planted, in December, at 6" × 3" rectangular spacing in beds of rested nursery soil. About half the cuttings were under the high shade and the remainder were under the woven laths. Results are given in Table XXXI.

TABLE XXXI
The Percentage Survival of Cuttings under Two Shade Treatments

<i>Treatment</i>	<i>Approx. per cent. full light</i>	<i>Cuttings planted</i>	<i>Per cent. survival</i>		<i>Mean for shades</i>
			<i>Exposed</i>	<i>Not exposed</i>	
High shade	1.9	24+25	57	37	47
Laths shade	9.6	20+23	75	59	67
Mean for scorch	—	—	66	48	57

The table shows there was better survival under the laths than under the high shade and as the experiment was done during the wet season this was probably due to reduced rain-drop damage and mud splash.

(e) *A Comparison of low Shades*

As mentioned previously, under a high shade some damage was caused by falling rain drops yet a low grass shade seemed to reduce the light excessively. This experiment compared three types of low shade with a no low shade treatment, all under a common high reed shade. The cuttings, all of the single internodal type, were planted at a spacing of 4"×3" triangular during February and recordings of survival were made during June.

The shade treatments were:—

1. High shade alone.
2. High shade plus a low shade of polythene sheeting 1 foot above the medium.
3. High shade plus a low shade of woven bamboo lath 1 foot above the medium.
4. High shade plus a low shade of grass 1 foot above the medium.

Results are given in Table XXXII.

TABLE XXXII
The Percentage Survival of Cuttings under Four Shade Treatments

<i>Treatment</i>	<i>Approx. per cent. of full light</i>	<i>Cuttings planted</i>	<i>Per cent. survival</i>
High shade alone	3.3	112	61
High shade plus polythene	3.1	100	38
High shade plus woven laths	0.3	88	68
High shade plus grass	0.2	100	48
TOTAL	—	400	54

Thus high shade alone and high shade plus woven laths seem to be better than high shade plus grass or polythene. In the case of high shade plus grass a light deficiency is suspected to be the depressing cause, but under the high shade plus polythene the cause is thought to be mud which splashed from outside the polythene and rebounded from the polythene on to the cuttings. Even the cuttings which were 2 feet from the outer edges of the polythene were covered with mud.

- (vi) TO INVESTIGATE THE EFFECT OF THE TERMINAL BUD STATE ON CUTTINGS MADE FROM THE SHOOT BELOW IT

It is thought that bud state is an indication of growth substance concentrations within the plant and may affect rooting. In this experiment the state of the terminal bud was taken as the indicator of growth substances present in that shoot. Material, was divided into two groups:—

- (a) Those shoots which had a growing terminal bud; and
- (b) those shoots whose terminal bud was dormant.

The shoots were then cut into single internodal cuttings. Two observations were made. The first, planted in July under high plus low shade, was spaced at 6"×6".

Results are given in Tables XXXIII and XXXIV below.

TABLE XXXIII

The Percentage Survival of Cuttings Demonstrating the Effect of the Terminal Bud

<i>Terminal bud state</i>					<i>Cuttings planted</i>	<i>Per cent. survival</i>
Growing ..	..	..	..	..	40	50
Dormant ..	..	..	..	..	40	30
TOTAL ..					80	40

The second observation was made during January and the cuttings were planted under laths at spacings of 3 inches between rows and the cuttings in the rows spaced so that the leaf of one cutting just touched the stem of the next cutting—i.e. at a leaf's length apart.

TABLE XXXIV

The Percentage Survival of Cuttings demonstrating the Effect of the Terminal Bud

<i>Terminal bud state</i>					<i>Cuttings planted</i>	<i>Per cent. survival</i>
Growing ..	..	..	..	..	30	76
Dormant ..	..	..	..	..	30	83
TOTAL ..					60	80

The results of the two observations do not agree and it is thought, at present, that the terminal bud state has little effect on the survival of cuttings made from the shoot below it.

- (vii) A COMPARISON OF VARIOUS ROOTING MEDIA

The most essential property of a rooting medium is the ability to retain moisture readily available to the cuttings, and at the same time have air spaces to ensure an adequate oxygen supply. These properties are usually found in fibrous materials and the experiment records the effect of "tea fluff" as a rooting medium. "Tea fluff" is the long fibrous waste matter from tea manufacture and is available locally.

Single internodal cuttings of two clones were planted at 3"×3" in six media during January. The media, in beds over a drainage layer of broken bricks and sand, were shaded by bamboo canes. The media used were:

- (1) Nursery soil passed through a quarter-inch sieve.
- (2) Tea fluff alone.
- (3) Tea fluff plus washed river-sand 1:1 by volume.
- (4) Nursery soil plus river-sand 1:1 by volume.
- (5) Nursery soil plus vermiculite 1:1 by volume.
- (6) Tea fluff plus vermiculite 1:1 by volume.

The tea fluff was slightly weathered and was soaked before use. The tea fluff alone was quickly attacked by termites and was never used. In the other media, containing tea fluff, all the cuttings died within two weeks of planting. The experiment was then abandoned. From the results it is concluded that tea fluff, in its untreated form, cannot be used for a rooting medium.

(viii) INVESTIGATION INTO THE POSITION OF THE CUTTING IN RELATION TO THE ROOTING MEDIUM

(a) *A Comparison of the Survival of Cuttings with Leaves in contact with the Rooting Medium against Cuttings with raised Leaves*

It was thought that some cuttings may be killed by fungi, an infection being caused, either directly or indirectly, by the contact of leaf and rooting medium. This experiment was designed to compare cuttings whose leaves might be in such contact, with others whose leaves were held away from the medium. Single internodal cuttings of one clone were planted in nursery soil at 3"×3" triangular spacing, during July. Half the cuttings were under high plus low shade and the other half were under high shade alone. Under each shade treatment half the cuttings were propped up with wire to prevent all contact between leaf blade and medium. The other half were planted with the usual half-inch space between leaf and medium and as some of the leaves wilted they came in contact with the medium. Results are given in Table XXXV below.

TABLE XXXV

The Percentage Survival of Cuttings with Raised Leaves, Four Months after Planting

Treatment					Per cent. survival		Mean for props
					High plus low shade	High shade alone	
Propped up	..	..	..	..	20+20	20	20
No props	..	..	..	..	20+20	25	38
Mean shades	..	..	..	..	—	23	35

From the table it may be seen that the props adversely affected survival.

(b) *A Comparison of the Spacing of Cuttings*

Fungal infection is often aided by closely spaced plants or cuttings. This experiment was intended to investigate the effect of spacing on the survival of cuttings. Single internodal cuttings of one clone were planted in July, at two spacings (a) 3"×3" triangular; and (b) 6"×6" square. Half of each spacing had high shade only and the other half had high plus low shade. Results are given in Table XXXVI.

TABLE XXXVI

The Percentage Survival of Cuttings at Two Spacings

Spacing				Cuttings planted	Per cent. survival		Mean
					High plus low shade	High shade alone	
3" × 3" Triangular	..	..	..	40+40	57.5	87.5	72.5
6" × 6" Square	..	..	..	40+40	77.5	80.0	79.0
TOTAL ..				160	62	84	76

The table shows a result favouring the 6" × 6" spacing under high shade plus low shade which is probably significant, but under high shade alone the effect of spacing on survival is much reduced.

STEM CUTTINGS IN COLD FRAMES

(i) INTRODUCTION

The frames made of brick and wood, were closed with a glass top approximately the design of a traditional " French light ". The bases of the frames were concreted with drainage channels, scoured and covered with a layer of weathered coal ash to ensure good drainage. Each frame was subdivided longitudinally, by a low brick partition, to enable a media trial to be made. The glass was raised 3 inches at its lower edge twenty days after planting the cuttings and then 3 inches at its upper edge a week later, thus ensuring air circulation, and yet keeping a high relative humidity. Shading was varied and one light was remade using polythene. Watering was sufficient to keep the soil in a friable ball state. Most of the experiments in the cold frames were repeats of those carried out in the previous section " STEM CUTTINGS OUT-OF-DOORS ".

(ii) THE EFFECT OF WOOD AND BUD STATES ON THE SURVIVAL OF HALF RIPE STEM CUTTINGS

This experiment is complimentary to Experiment out-of-doors (ii) but was carried out in frames instead of in the open. The key to the three wood and bud conditions is as detailed in para 117. Results are recorded in Table XXXVII below.

TABLE XXXVII

The Percentage Survival of Cuttings, in relation to Wood and Bud States grown in Frames

Bud state				Cuttings planted				Per cent. survival			
				Wood state				Wood state			
				t	m	b	Total	t	m	b	Total
d ..	..	..	..	7	29	120	156	87	59	68	67
s ..	..	..	..	6	84	85	175	50	61	55	58
e ..	..	..	..	30	51	35	116	77	73	67	72
c/a ..	..	..	..	10	23	36	69	10	48	44	41
TOTAL ..				53	187	276	516	62	62	61	61

The result shows very little difference in survival due to the wood state and this is in agreement with the results in Table XXVI. As in the trial in the open there is not a great difference in the effect of the bud states, except the depressing effect of a removed axillary shoot. The overall survival of 61 per cent. in the frames compares favourably with 43 per cent. out in the open.

(iii) TO INVESTIGATE THE OPTIMUM PERIOD FOR TAKING HALF-RIPE STEM CUTTINGS

This experiment is complimentary to out-of-doors experiment (iii). The cuttings were planted during two periods: (a) during the dry season (August) and (b) during the rainy season (February) and recordings of survival were made three months after planting, as shown in Table XXXVIII.

TABLE XXXVIII

The Percentage Survival of Cuttings planted at various Periods grown in Frames

<i>Planting period</i>						<i>Cuttings planted</i>	<i>Per cent. survival</i>
August	..	..	..	..	..	156	60
February	..	..	..	..	..	360	62
TOTAL ..						516	61

The two chosen periods of planting cuttings would not seem to effect the survival of cuttings in frames, contrary to the clear seasonal effects recorded in the open. The overall survival (62 per cent.) compares favourably with the overall survival (43 per cent.) in the open and the rainy season results (frames 62 per cent. open 12 per cent.) show one of the advantages of frames.

(iv) A COMPARISON OF THREE TYPES OF HALF-RIPE INTERNODAL STEM CUTTINGS

This experiment is complimentary to out-of-doors experiment (vi). Survival was recorded three months after planting, and is shown in Table XXXIX.

TABLE XXXIX

The Percentage Survival of Three Types of Half-Ripe Cuttings grown in Frames

<i>Type of cutting</i>						<i>Cuttings planted</i>	<i>Per cent. survival</i>
Single internode (1)	..	..	..	..	..	36	100
Double internode (two leaves) (2)	..	..	..	..	..	36	67
Double internode (one leaf) (2-1)	..	..	..	..	..	36	79
TOTAL ..						108	82

The results favour the single internode type of cutting (1) and as the other two types use twice the amount of material, the single internode type should be used. The results are in agreement with those of Table XXVIII but it is interesting to note that the overall survival is 82 per cent. in the frames compared with 39 per cent. in the open.

(v) TO OBSERVE THE EFFECT OF A COPPER FUNGICIDAL DIP ON THE SURVIVAL OF CUTTINGS

In the out-of-door experiments the aim was to reduce fungal attacks by avoiding contact of leaf and medium. In this experiment the protection was from a copper fungicide in which the cuttings were dipped before planting. Single internodal cuttings of one clone were prepared, half of them being dipped in "Super Blitox 12" at 1 oz. per gallon and the other half being placed in water. Half of each treatment was planted in nursery soil and the other half was planted in vermiculite. Half of both copper and media treatments were shaded by laths over polythene sheet and the other half by Snowcem on glass. The cuttings were planted during February and survival was recorded during May, as shown in Table XL. The slight decrease in survival is not significant.

TABLE XL

The Percentage Survival of Tea Cuttings treated with a Copper Fungicide totalled over the Other Treatments

Treatment					Cuttings planted	Per cent. survival
Copper dipped	..	..	..	..	60	77.5
Control	..	..	..	..	60	78
TOTAL					120	77.5

(vi) A COMPARISON OF NURSERY SOIL WITH VERMICULITE AS A ROOTING MEDIUM FOR HALF-RIPE INTERNODAL CUTTINGS

Cuttings of various types and of various clones were planted at 3" x 3" triangular during February and August. One half of the cuttings was planted in vermiculite and the other half was planted in a nursery soil. The vermiculite of $\frac{1}{8}$ "— $\frac{1}{4}$ " particle sizes was poorly expanded and alkaline (pH 7). Results are recorded in Table XLI.

TABLE XLI

The Percentage Survival of Cuttings planted in Two Media, Three Months after Planting

Media					Cuttings planted	Per cent. survival
Soil	..	..	..	..	258	73
Vermiculite	..	..	..	..	258	50
TOTAL					516	61.5

The result shows better survival in soil. Most of the soil survivors were rooted, whereas most of the vermiculite survivors had a callus but no roots.

(vii) TO OBSERVE THE EFFECT OF SHADE ON HALF-RIPE STEM CUTTINGS IN COLD FRAMES

This was an initial investigation into the effect of light intensities on cuttings, and as the meters for measuring light were not received until late June the accuracy of the light percentages can only be approximate. All conditions and material are as described in para 144 and results are recorded in Table XLII.

TABLE XLII

The Percentage Survival of Cuttings under several Shade Treatments

Shade			Details	Light as per cent. full light	Cuttings planted	Per cent. cuttings survived
1.	Hessian	..	Inside the glass	0.5	360	0
2.	Aluminium paint	..	Two coats undiluted	N.R.	48	12
3.	Aluminium paint	..	1 coat diluted 1:3 with petrol	N.R.	5	0
4.	Lime wash	..	2 coats	8.5	54	91
5.	" "	..	4 coats	3.3	54	72
6.	Snowcem	..	3 coats plus laths	0.4	60	50
7.	" "	..	3 coats	4.0	60	60
8.	Polythene plus laths	..	(poly: 10 thou.)	9.0	60	80
9.	No shade	..	Inside frame walls	100.0	—	—

N.R.=No records.

The hessian and undiluted aluminium paint are thought to have been excessive shade and the diluted aluminium paint to be insufficient shade. The table would seem to indicate that light plays an important part in the rooting of cuttings and from the results there would seem to be a beneficial light of around 8 per cent. of full light.

AIR LAYERING

(i) INTRODUCTION

In air layering a branch is wounded and the wound is kept moist, usually until roots have formed. In the following experiments the moisture was held in vermiculite (a sample of $\frac{1}{8}$ inch to $\frac{1}{4}$ inch particle size and pH of 7) and was retained by polythene—a substance which permits the passage of gases yet not of water vapour. Thus the method is an adaptation and simplification of marcotting and although still not a simple method of propagation it has been found, in some cases, practical for propagating a few plants from a parent bush which cannot be readily propagated by other methods.

In the following experiments the parent bushes were tea seedlings about eight years old which had not been pruned since July, 1955. The layers were made six nodes below the terminal bud some on mature and others on green wood. Three types of wound were used. A growth substance treatment was observed. The effect of direct sun and the effect of the terminal bud state were recorded. None of the air layers rooted, but callus was present in many cases. Although a callus is no certain indication of subsequent roots, the callus has been taken as a satisfactory end point because of the observations on para 152 where vermiculite lead to callus but few roots.

(ii) A COMPARISON OF AIR LAYERS IN DIRECT SUNLIGHT WITH OTHERS IN THE SHADE

The layers were made during several months and on several seedlings so as to overcome time and clonal factors. In the results recorded in Table XLIII, survived means that neither roots nor callus were present but the leaves and buds above the wound were still alive.

TABLE XLIII
The Effect of Sunlight on Air Layers

<i>Treatment</i>					<i>Air layers</i>	<i>Per cent. callused</i>	<i>Per cent. survived</i>	<i>Total</i>
Direct sunlight	..	..	..	..	126	31	9	40
Shaded	..	..	..	..	58	78	15	93
TOTAL ..					184	46	11	57

The results show the depressing effect of direct sunlight on air layers.

(iii) THE EFFECT OF THREE TYPES OF WOUNDS IN AIR LAYERS

The conventional wound is an oblique cut, of about 1 inch length which cuts half way through the stem. When tried this method leads to several breakages, during and after making the layers. Consequently other types of wound were investigated. The three types of wound were:

- (i) The oblique cut.
- (ii) The removal of a girdle of bark—about 1 inch in width.
- (iii) The removal of two opposite half girdles of bark, each half inch in width and leaving a half inch gap between them.

TABLE XLIV
The Effect of Three Types of Wound on Air-layers

<i>Wound</i>					<i>Air layers</i>	<i>Per cent. callused</i>	<i>Per cent. survived</i>	<i>Total per cent.</i>
Oblique cut	..	..	..	..	48	31	21	52
Girdle	..	..	..	..	68	46	7	53
Two half-girdles	..	..	..	..	68	56	9	65
TOTAL ..					184	46	11	57

The results favour the two half-girdle type of wound and from observations it would seem that a callus forms quicker from a girdle or half girdle wound than it does from an oblique cut.

(iv) TO RECORD THE EFFECT OF A GROWTH SUBSTANCE ON AIR LAYERS

The use of a growth substance is often found to accelerate the formation of roots and this experiment was to record the effect of Seradix B on air layers of tea. Half of the wounds were dusted with Seradix B, excess powder being blown off, while the other half was untreated.

TABLE XLV
The recorded Effect of Seradix B on Air layers

<i>Treatment</i>					<i>Air-layers</i>	<i>Per cent. callused</i>	<i>Per cent. survived</i>	<i>Total per cent.</i>
Seradix B	..	..	..	..	92	50	13	63
No growth substance	..	..	..	..	92	41	10	51
TOTAL ..					184	46	11	57

Thus it would seem that Seradix B aids the callusing and survival of air layers on tea.

(v) TO RECORD THE EFFECT OF WOOD STATE ON AIR LAYERS

Although all layers were made six nodes from the end of a shoot, some were made on "red barked wood" whilst others were on the softer "green wood".

TABLE XLVI
The recorded Effect of Wood State on Air layers

Wood state	Air layers	Per cent. callused	Per cent. survived	Total per cent.
Red barked	94	61	8	69
Green barked	90	30	14	44
TOTAL ..	184	46	11	57

Thus the more mature wood seems to be more suitable for air layers than the soft green barked wood.

(vi) TO RECORD THE EFFECT OF TERMINAL BUD STATE ON AIR LAYERS MADE ON THE SHOOT BELOW IT

As stated previously it is thought that bud state might reflect concentrations of growth substances which in turn might effect rooting. The state of the terminal bud on shoots which were air layers was recorded. The culture and method are as in the previous experiments but the majority of the layers were in the direct sunlight which leads to an overall survival of 47 per cent. compared with the gross overall of 57 per cent.

TABLE XLVII
The Effect of Terminal Bud State on Air layers

Bud state	Air layers	Per cent. callused	Per cent. survived	Total per cent.
Dormant	59	22	17	39
Growing	85	40	13	53
TOTAL ..	144	33	15	47

Thus growing terminal buds lead to greater success than the dormant buds.

POT EXPERIMENTS

(i) INTRODUCTION

The use of pots allows the propagator easier movement of material and more control over conditions of growth. Pots are useful where different media are to be compared. In all the pot experiments the pots, of burnt clay and traditional shape with top diameters $3\frac{1}{2}$ inches and 5 inches (about large 60's and 48's), filled with various media, were placed on a layer of weathered coal ash, were watered daily and were shaded with woven bamboo laths about 3 inches above the cuttings. A double layer of laths was used for the first ten days from planting. Some of the cuttings were planted one to a pot centrally placed, and others were planted four to a pot marginally placed. The cuttings, all single internodal half-ripe cuttings, were planted in early March and survival was recorded in mid-June. All treatments were randomized.

(ii) A COMPARISON OF POT SIZE AND ITS EFFECT ON THE SURVIVAL OF CUTTINGS

The large pots, which hold more medium, should dry out less quickly than the smaller pots and the experiment was intended to record the effect of pot size on the rooting of cuttings. The method is as described in the introduction and results are recorded in Table LXVIII below.

TABLE LXVIII
The Percentage Survival of Cuttings in Two pot Sizes

Pot size		Cuttings planted	Per cent. survival
Top diam.	Cast size		
3½"	(60)	199	34
5"	(48)	200	52

The figures show that the 5 inch pots gave a higher survival than 3½ inch pots.

(iii) TO COMPARE A SINGLE CENTRALLY PLANTED CUTTING AGAINST FOUR marginally PLANTED CUTTINGS AND THE EFFECT ON SURVIVAL

It is a commonly held hypothesis that cuttings tend to root better if planted touching the edge of a pot. This experiment was designed to apply this knowledge to tea propagation. Culture was as described in the introduction, half the pots being planted with one cutting in the centre, the other half being planted with four cuttings equally spaced round the perimeter. Results are recorded in Table XLIX.

TABLE XLIX
A Comparison of centrally and marginally planted Cuttings in Pots

Treatment					Cuttings planted	Per cent. survival
Single—centrally planted	..	..	..	..	79	43
Fours—marginally planted	..	..	..	..	320	43
TOTAL ..					399	43

This result does not support the theory that marginal planting is beneficial, but it should be borne in mind that there is a great saving of pots, media and space where four cuttings are grown in one pot.

(iv) TO COMPARE VARIOUS MEDIA AND THEIR EFFECT ON THE SURVIVAL OF CUTTINGS

A rooting medium must contain available moisture and oxygen, but nutrients are not essential. The experiment compared mixtures of five media. The media and mixtures, all by volume, are listed under the results.

The compost was decomposed vegetable matter passed through a ¼ inch sieve.
The soil was rested nursery soil, passed through a ¼ inch sieve.

The sand was unwashed river sand.

The vermiculite was a poorly exfoliated sample of ⅛ inch to ¼ inch particle size.

The peat was Dutch peat passed through a ¼ inch sieve.

The peat and vermiculite were soaked before being used.

Results are recorded in Table L.

TABLE L
The Percentage Survival of Cuttings in various Rooting Media

<i>Medium</i>	<i>pH</i>	<i>Mixture by volume</i>	<i>Cuttings planted</i>	<i>Actual survival per cent.</i>
Soil	5.5	—	79	49
Soil plus compost	6.0	1:1	40	20
Soil plus sand	6.0	1:1	40	50
Soil plus vermiculite	5.75	1:1	40	23
Sand plus peat	5.75	1:1	80	40
Soil plus sand plus compost	5.5	7:2:3	40	65
Soil plus sand plus vermiculite	6.0	7:2:3	40	60
Soil plus compost plus vermiculite	5.75	7:3:3	40	40
TOTAL ..	—	—	—	—

Sand as a component of the rooting medium seems to be beneficial, but in another experiment, not yet recorded, sand alone, (which was alkaline) has a very low survival.

Summary of Vegetative Propagation Investigation

Although the experiments on vegetative propagation described above are of a preliminary nature, and there are many gaps in our knowledge yet to be filled, it is thought that the following points will assist estates which want to begin this work at once:

(i) *Propagating Beds.* These can be out-of-doors or in easily constructed cold frames. The cold frames have produced a higher percentage survival than out-of-doors especially if propagation is done during the rainy season. It is assumed that estates would prefer the out-of-doors technique.

(ii) *Medium.* Ordinary nursery soil is satisfactory but care must be taken in preparation to ensure that the medium is firm and consolidated before planting of cuttings. Puffiness in the medium is detrimental to survival. Efficient drainage is necessary.

(iii) *Shade.* This is essential and the bamboo lath type of shade supported on brick seems to be the most promising.

(iv) *Time of Striking Cuttings.* Under the shade regimes so far examined the best time is undoubtedly between April and August.

(v) *Parent Material.* Any shoots of up to twelve months of age would appear to be suitable, with the possible exception of the soft apical portion. All states of axillary bud development may be used with the exception of those which have actually produced a shoot.

(vi) *Type of Cutting.* The single node type of cutting is recommended. It is certainly the most economical as far as material is concerned.

(vii) *Watering.* The amount of water required has not been critically examined, but a good soaking of the propagating beds 24 hours before planting of cuttings is recommended. Thereafter, enough water should be applied to keep the soil moist but not wet.

Sundry Works

(i) ROOT CUTTINGS

A trial of propagating tea by root cuttings is in hand. Cuttings are made every month from the roots of 22-year-old seedlings. The cuttings are about 6 inches in length, and planted vertically with about $\frac{1}{8}$ inch exposed above soil level. The length of exposure gradually increases as the soil compacts. The cuttings are taken monthly in an attempt to discover any period of high regeneration, as has been found with some other species. The experiment is not yet complete and no detailed results are available for record, but so far about 25 per cent. of the root cuttings have produced roots.

(ii) MIST PROPAGATION

The lack of mains electricity and water services has made the setting-up of a mist propagation unit difficult, but planning arrangements are now almost complete and it is hoped to have the unit in operation before the end of 1957 if the delivery of the equipment, which has to be imported, is satisfactory.

(iii) PLANT LABORATORY

During the year a small plant laboratory has been erected. It is 20' x 13', made of Mlanje Cedar, on brick side walls, and covered with polythene of 10 thou. thickness. Ventilation includes both top-and side-lights. Although polythene has been used the woodwork is such that glass can easily be fitted should the polythene not be satisfactory.

Selection and Breeding

A programme of this work was drawn up and approved by the Tea Research Committee in February, 1957. So far only certain preliminary work has been done, including the following:—

(i) Collection and establishment in nurseries of progenies from all available seed sources. So far seed has been obtained from 17 different seed gardens.

(ii) Selection of seedling types to be planted out in the coming rains with a view to looking for juvenile characteristics which can be linked with yield and quality, etc. in the mature bush.

(iii) A preliminary examination of the yield characteristics of an Indian jat typical to Nyasaland.

(vi) The development of a bud-grafting technique to speed up production of flowers on selected material.

(v) A study of controlled pollination techniques.

Extract from Agricultural Chemist's Report

(i) TEA NUTRITION

Following up the findings detailed in the 1954-5 Report regarding the apparent reduction in soil potash supplies in older tea areas, one such field has been selected for an NPK fertilizer experiment, to compare responses with most of the current experiments on more recently established tea. Details of the top soil of this particular field were as follows:—

pH:	Sand	Silt	Clay	Org. carbon	N.	Phosphate available	Res.	Base cap.	Ca.	Mg.	Na.	K.
5.0	54	28	16	2.1	0.20	44	101	8.7	2.6	0.4	0.15	0.19

Leaf samples were also examined from this field, their composition being:—

						N.	P.	K. per cent.	Ca.	Mg.
Two leaves and bud	..	..	..	..	..	3.95	0.34	1.41	0.49	0.32
Bud only	..	..	..	..	..	5.08	0.45	1.43	0.57	0.17
First leaf	..	..	..	..	..	4.37	0.38	1.48	0.35	0.33
Second leaf	..	..	..	..	..	3.80	0.31	1.48	0.35	0.43
Fourth leaf	..	..	..	..	..	2.76	0.21	1.08	0.86	0.52

Although the K status of the leaf is rather lower than some other samples examined, it is still well above the figure of 0.6 per cent. which was found in the trees showing deficiency symptoms in Ceylon. The fourth leaf sample which, as would be expected contains less potash due to migration, but the level is still above that at which a deficiency might be expected. It therefore appears that though the level of exchangeable potash may have been reduced over the years, the soils are sufficiently rich in mineral reserves that potash is being continually mobilized at a rate sufficient to supply the needs of the crop.

Soil and leaf samples were also taken from other fertilizer experiments on estates, to see what range of nutrient levels were already covered by existing experiments. The sites summarized as:—

						N. per cent.	P. ppm.	K. mge/100 gm.
Swazi Tea Station	..	..	..	..	..	0.07-0.14	10-30	0.3-0.4
Mimosa (1)	..	..	..	..	..	.13	140	0.29
" (2)	..	..	..	..	..	.11	23	0.27
Magombe Estate	..	..	..	..	..	.10	4-11	0.4
Thornwood Estate	..	..	..	..	..	.15	40-70	0.4-0.6
Bandanga Estate	..	..	..	..	..	.13	50-90	0.5-0.9

It is thus seen that together with the new experiment referred to above, a full range of P and K levels is now covered.

For comparison with the composition of leaf from the low K area (*see above*), the following figures for leaf from Bandanga Estate, may be quoted, as here the K is at a higher level.

						N	P	K	Ca.	Mg.
Two leaves and bud	..	..	..	..	..	3.18	0.28	1.80	0.76	.37
First leaf	..	..	..	..	..	4.38	0.31	1.54	—	—
Second leaf	..	..	..	..	..	3.68	0.28	1.75	—	—
Third leaf	..	..	..	..	..	3.32	0.26	1.74	—	—
Fourth leaf	..	..	..	..	..	2.46	0.20	1.19	—	—

(ii) TEA NURSERIES

(a) An area for a proposed nursery site on one estate was examined and showed that the better soils would be at the top of the slight hill, rather than on the lower slopes near the stream—although the latter type of site is often selected because of the accessibility to water. As has been mentioned in previous Reports, such lower sites are often unsatisfactory, due to clay pans or laterite layers. The pumping of water to a better and higher site would therefore be warranted.

(b) In a further nursery, poorer growth appeared due to the increased pH (6.5) of the subsoil.

(iii) POOR GROWTH OF TEA

Poor growth of tea was reported from one estate and this was again attributed to an old *khola* and hut site, which had caused a higher pH of the soil. There was an interesting gradation in the extent of dieback in the tea, which had not been seen together on any one site before, and which was associated with the pH in the following way:—

					Moderate	Poor	Worst
0-6"	..	..	..	..	6.9	6.6	7.5
12"-15"	..	..	..	..	6.5	7.0	7.4

(vi) VEGETATIVE PROPAGATION

As the percentage strike is increased by a higher C/N ratio in the leaf, initial small-scale tests were made to see if the spraying of potash, phosphate or nitrogen would affect this ratio. The total nitrogen was determined in the leaf, and an estimate of the total carbon compounds was made by dichromate oxidation, the results being:—

Treatment	Sept. Expt. (1 week after spraying)			Oct. 10th (1 week)			Oct. 27th (3 weeks after spraying)		
	N	C	C/N	N	C	C/N	N	C	C/N
Control	2.65	30.4	11.5	1.59	35.9	22.6	—	—	—
1 per cent. urea	2.88	31.2	10.8	1.58	35.8	22.7	1.68	36.1	21.6
Control	as above			1.99	36.0	18.2	—	—	—
1 per cent. sugar	2.68	30.7	11.1	1.91	36.5	19.1	1.89	36.0	19.0
Control	as above			2.48	38.2	15.4	—	—	—
1 per cent. KH_2PO_4	2.51	31.3	12.4	1.66	36.3	21.9	2.42	36.1	14.9
Control	as above			2.13	35.8	16.8	—	—	—
1 per cent. KCl	2.76	28.9	10.5	2.07	36.2	17.5	1.68	36.5	21.8

The "control" indicated under October 10th is the leaf taken from the specific plot before spraying. An adjoining plot was used as a control throughout the three weeks, and the figures for leaf from this are:—

October 5th	2.07	30.7	14.8
" 10th	1.65	34.7	21.5
" 27th	1.58	36.6	23.2

In the September experiment, control leaf was not taken from each plot separately.

As is seen, there is some range in the results, but generally urea and sugar seem to have had little effect. The potassium chloride shows a steady increase in the C/N ratio, but this is partly nullified by the fact that the control block also shows a similar increase in October, although not doing so in September. The potassium phosphate showed an increase in September but not in October. It does appear that there may be some benefit from potash, which warrants further investigation.

(v) TEA FERMENTATION—INTERIM REPORT

The initial stage of an investigation into the factors affecting the quality of Nyasaland teas have been devoted to a general study of nutrient, caffeine and tannin levels, involving the introduction of several new analytical methods. Although no conclusive deductions, can as yet, be drawn from the figures, much original information has been obtained, facilitating the compilation of a more specific research programme for the coming season.

The investigation to date has covered two main aspects, copper content and fermentability assessment. As a copper protein, polyphenoloxidase, motivates the enzymic oxidation or so-called fermentation, particular attention has been paid to the tea leaf's copper content. Coupled with this a general assessment of minor nutrient status has also been made.

Eight estates have, during the past season, submitted 103 leaf samples and the range of levels is shown below.

Minor Element Status of Nyasaland Teas—determined on Apical Bud with two Immature Leaves attached. Contents in p.p.m. m = mean r = range

<i>Estate</i>	C1		C2		E1		L1		L2		M1		S1		S2	
	m	r	m	r	m	r	m	r	m	r	m	r	m	r	m	r
No. samples	15		4		35		2		8		22		4		13	
Aluminium	300	185-430	—		205	11-290	—		—		—		—		570	570-575
Boron	9.3	6.8-12.6	8.7	6.3-11.8	28.0	25.0-31.0	—		—		—		—		17.4	13.5-21.5
Copper	115	80-235	—		14.7	5.0-20.7	7.5	4.8-10.2	—		—		—		210	125-250
Iron	430	290-720	200	160-280	70	55-105	—		—		—		—		730	465-945
Manganese	26.9	15.7-37.	28.6	13.3	595	335-695	—		200	160-280	430	135-1085	355	310-425	55.7	51.0-64.2
Zinc					30.5	18.6-50.0	21.5	18.4-24.8	23.6	13.3-39.3	31.1	24.3-48.4	29.9	19.4-52.8		

Although the copper contents are lower than those of Indian teas (18.2–38.7 p.p.m.) they are similar to East African teas (although few figures for this area are available). It is interesting to note the variation in copper, manganese and zinc contents down the stem e.g. :—

						Copper	Manganese	Zinc
							p.p.m.	
Estate EI	Apical bud	..	..	..	..	18.0	190	38.0
	1st leaf	..	..	..	..	18.7	430	40.0
	2nd leaf	..	..	..	..	14.6	425	31.5
	3rd leaf	..	..	..	..	12.2	665	32.8
	Stem	..	..	..	..	10.4	550	20.3

It is seen that copper is higher in the immature leaves, which give the best quality tea. The tea-planter, of course, always aims at plucking “two and a bud” and coarser plucking lowers quality.

Fermentation characteristics were assessed by inspection of the assessment with leaf, half-an-hour after mincing (simulating the rolling process). There is a tendency for the better fermenters to contain more copper, viz.

Fermentation quality No.					Samples	Total mean	Copper content* range
3 (good)	..	..	..	..	13	14	8–24
2 (medium)	..	..	..	..	5	19	16–23
1 (poor)	..	..	..	..	13	14	7–27
0 (non-)	..	..	..	..	4	20	13–28

* To nearest p.p.m.

No definite conclusion can be drawn from those figures and, indeed, there are cases of a good fermenter on one estate having a copper content, say, of 10 p.p.m. whilst, on another estate, a non-fermenter contains 10 p.p.m. and the good fermenter 20 p.p.m. One non-fermenter contained 32 p.p.m. copper—the highest found in any sample. As there does not appear to be any direct relationship between fermentability and total copper content it seemed that better correlation might be found if “protein” copper were considered. Attempts have therefore been made to separate inorganic and organic copper. Various solvents, e.g. acetone, were used in conjunction with a high-speed macerator and subsequent centrifuging, in an endeavour to isolate the leaf chloroplasts containing polyphenoloxidase. Copper determinations on the ultimate residues proved very low and showed that complete chloroplast separation was not being achieved.

If Nyasaland teas are inherently low in copper, it might be possible to improve their quality by direct application of copper to the plant. Some years ago Bordeaux sprays proved effective on a particularly poor area of tea in Mlanje District. But for practical purposes, soil application would be more suitable. Various estates therefore co-operated in copper sulphate trials. Trial plots were selected and ground applications of copper sulphate made, at intervals, at levels of either 0, $\frac{1}{2}$, 1 oz. per bush or 0, 1, 2 oz. per bush. Copper contents were then determined through the season, in order to follow the copper uptake, if any. Fermentation qualities were also checked for improvement with copper uptake. Most of the trials proved insignificant, although two estates showed response, vide table below.

Variation in Copper Content with Copper Sulphate Application

Copper Content, p.p.m.

<i>Estate</i>			L1	S2	E1		
				Oct., 1956	Nov., 1956	Dec., 1956	Jan., 1957 Apr., 1957
Control 1	..	..	4.8	13.5	18.4	16.4	16.7 7.8
Control 2	..	..	—	—	—	13.1	20.7 9.4
$\frac{1}{2}$ oz. CuSO ₄	..	..	—	—	—	16.4	16.2 9.0
1 oz. CuSO ₄	..	..	—	—	—	15.8	20.7 12.4
2 oz. CuSO ₄	..	..	10.2	17.9	21.2	—	— —

No marked improvements in fermentation were observed. The figures indicate that a 2 oz. application of copper sulphate is more efficacious and also show very markedly the variation in leaf content through the season (cf. controls). It can be seen that copper contents are higher at the commencement of the season.

Soil samples were also examined from each of these experiments, to assess the possible fixation of the applied copper by organic matter. The organic matter contents were L₁ 3.2 per cent., S₂ 4.3 per cent., and E₁ 5.7 per cent. The range of these figures is not wide but it is noted that the increase in copper content of the leaf is greatest in the soil of lowest organic matter, but whether this may also be related to the lower initial copper content is still being investigated.

In addition to quality assessment by fermentation tests, determinations are also being made of the tannin and caffeine contents. Thus a poor fermenter may contain adequate tannins and insufficient enzyme or the enzyme level may be satisfactory but the oxidisable matter may be low. Tannins have been assessed by determination of Total Oxidisable Matter. Attempts to correlate T.O.M. with total copper content have not always been successful but some interesting results have come to light, e.g. the variation in T.O.M. down the stem. (cf. copper content down the stem.)

Estate E1	{	Bud ..	..	..	285 T.O.M. (as ml. 0.05N Iodine per gm).
		1st leaf	..	..	295 "
		2nd leaf	..	..	275 "
		3rd leaf	..	..	245 "

As fermentation will bring about a decrease in the T.O.M. content, the better the fermenter, the less will be the residual T.O.M. From one estate, residual T.O.M.s from a "good" and a "poor" fermenter were 205 and 265 respectively. Other teas, known to be very good fermenters, showed residual T.O.M.s of 70 and 125. This aspect of the problem is being investigated in conjunction with an U.V. absorption method for following fermentation changes.

Caffeine determinations show that Nyasaland teas are well supplied with the stimulant. Figures obtained range from 2.3 to 4.6 per cent.

Initially, several samples of good fermenting leaf were bulked for copper determination, but it is now clear that each bush must be treated separately, owing to clonal variation. Although "Two leaves and a bud" samples are collected at present it is realized that the rate of decrease in copper content down the stem is not uniform for all bushes, and it may eventually be necessary to work on samples of a specific leaf and bud, or first or second leaf. As there is a minimum weight required for analysis and as seasonal variation would complicate accumulation of leaf samples, the practical difficulties are appreciable. It has also been observed that many of the better fermenting bushes tend to be low yielding.

(v) CONCLUSION

These analyses show that total copper contents, lower than those found in Asian tea growing territories, bear little relationship to fermentation quality; that T.O.M. and caffeine contents are at reasonable levels. The coming season will necessitate further work on the same lines, with particular attention being paid to the determination of protein copper and its correlation with T.O.M. and quality.

Meteorological Record 1956/57 at Mimosa Tea Research Station, Mlanje

Month	Rain ins.	Rain days	Running Total	8 year mean	Mean monthly max. °F	1 year mean	Mean monthly min. °F	1 year mean	Hours sun	3 year mean
July, 1956 ..	0.63	4	0.63	1.46	72.0	72.0	52.0	52.0	188	178
August ..	1.49	4	2.12	1.72	80.2	80.2	53.8	53.8	225	226
September ..	0.52	7	2.64	0.57	81.6	81.6	57.4	57.4	204	206
October ..	1.11	9	3.75	2.87	88.5	88.5	61.8	61.8	255	279
November ..	12.51	22	16.26	8.26	83.1	83.1	65.0	65.0	123	176
December ..	11.25	26	27.51	10.71	82.6	82.6	65.7	65.7	111	153
January, 1957 ..	20.90	27	48.41	12.57	82.8	82.8	64.4	64.4	125	163
February ..	3.40	17	51.81	10.93	85.0	85.0	63.3	63.3	198	181
March ..	4.62	23	56.43	12.49	83.0	83.0	65.8	65.8	133	147
April	2.72	15	59.15	6.82	81.9	81.9	62.8	62.8	185	186
May	5.19	12	64.34	3.18	76.7	76.7	56.8	56.8	188	193
June	1.18	7	65.52	2.01	75.1	75.1	52.3	52.8	136	145
TOTAL ..	65.52	173	65.52	73.59	—	—	—	—	2,071	2,312

This is the first full year of recording at Mimosa.

TUNG

1. Production of Improved Planting Material

1.1 BUDDINGS VERSUS SEEDLINGS

The superiority of budded clonal material over seedlings has been well established by the classical experiment planted at Bvumbwe in 1940 and is illustrated by this year's results.

Buddings versus Seedlings, 1957

(Yield in lb. air dry seed per tree)

Treatment	Clones				Mean	Yield per acre	L.S.D.	
	M8	M13	H14	F9			P=0.05	P=0.01
Montana Stock	29.1	19.2	22.5	14.3	21.3	1193	4.7	6.5
Fordii Stock	24.3	21.7	14.9	19.6	20.2	1131	(262)	(362)
Selected Seedlings ..	19.4	19.1	10.9	14.3	15.9	890	—	—
Unselected Seedlings ..	—	—	—	—	13.5	756	—	—
L.S.D. Clones								
P=0.05 ..	8.6	—	—	—	—	—	—	—
P=0.01 ..	11.9	—	—	—	—	—	—	—
Yield per acre (Short tons)	1361	1120	902	902	991	—	—	—

Only M8 and H14 on *montana* stock are significantly better than selected seedlings, the *fordii* buddings of the other two clones tending to be the high yielders. The performance of buddings on *montana* stock has always been better than buddings on *fordii* stock until 1953 when no significant difference was reported between the yields, particularly for the "B" type clone F9. It was suggested that, as these higher *fordii* yields coincided with abnormally low rainfall periods, *fordii* stock was more drought-resistant. Furthermore, in view of the susceptibility of *montana* rootstock to *Armillaria* root disease and the comparative resistance of *fordii* to it, the possible use of *fordii* stock for "B" type clones appears worth examining more closely.

Montana versus Fordii Stock 1952/57

Stock Scion*			1952	1953	1954	1955	1956	1957	Mean	L.S.D. P=0.05
Montana M8	..	..	56.5	27.2	42.9	35.9	43.7	29.1	39.2	5.7
Fordii „	..	..	36.2	16.1	37.4	28.4	35.7	24.3	29.7	
Montana M13	..	..	54.4	20.4	49.2	28.3	49.4	19.2	36.8	
Fordii „	..	..	35.3	18.6	43.7	32.3	34.3	21.7	31.0	
Montana H14	..	..	56.7	20.1	43.7	25.0	48.6	22.5	36.1	
Fordii „	..	..	39.3	11.3	51.8	18.9	55.2	14.9	36.9	
Montana F9	..	..	36.7	15.5	37.9	15.2	34.6	14.3	25.7	L.S.D. P=0.05
Fordii „	..	..	32.6	14.9	39.3	24.5	37.2	19.6	28.0	
Mean <i>montana</i>	..	..	51.1	20.8	43.4	26.1	44.0	21.5	34.5	2.6
Mean <i>fordii</i>	..	..	35.9	15.2	43.1	26.0	40.6	20.1	21.8	

L.S.D. between stock means for a given scion (P=0.05) = 2.1

*M8 and M13 and H14 are A-types and F9 is a B type.

The above table shows that over the last four years F9 buddings on *montana* stock have been outyielded by buddings on *fordii* stock and that there is no difference between yields of H14 on either stock.

The first year's crop from the trial of *fordii* seedlings and buddings confirm last year's Report, based on girth measurements, of the superiority of the budded *montana* clone 10.

Performance of *fordii* seedlings and buddings

(lb. dry seed)

Treatment	Mean Yield per tree
Montana clone 10 on <i>montana</i> rootstock	7.9
Local <i>fordii</i> seedlings NZ101	1.4
" " seedlings NZ5	0.8
<i>Fordii</i> seedlings ex-Swaziland	0.7
U.S.A. <i>fordii</i> seedlings Lampton F578	0.6
L.S.D.	
P=0.01	0.8

All other treatments produced negligible yields. The local seedling NZ101 and the Swaziland seedlings were not cut back and there was less check on their growth.

1.2. CLONAL TRIALS

Observation plots on the Vipya, concluded this year, have shown the local superiority of the vigorous B-type clone 04 over the B-type clone 14 and A-type M13.

Mean Yield of Clones on the Vipya, 1953/1957

(Pounds per acre)*

Location	Clones		
	04	14	M13
Lusangadzi Whitesands	1723	1203	1196
Mzuzu Good Soil	1794	1378	1125
Mzuzu Poor Soil	598	403	592

*Assuming a fully planted plantation of 65 plants per acre (26' × 26' spacing)

At Bvumbwe a trial of newer clones compares favourably with trees of the same age (planted 1947) of some of the more widely-planted clones, M13 and 10.

New clones at Bvumbwe

(lb. dry nuts)

Clone	Yield per tree	Yield per acre at 27' × 27' spacing	Remarks
M13	42.1	2358	Widely planted A-type
10	29.0	1621	" " Vig. B-type
E 565	63.5	3556	New Vig. B-type
G 88	58.3	3265	New A-type
G 87	58.0	3248	New Vig. B-type
G 57	49.8	2789	New Vig. B-type
G 43	44.3	2481	New A-type
G 112	43.5	2436	New Vig. B-type
E 460	26.7	1495	Topworked 1953. A-type
C 946	9.8	549	Topworked 1954. A-type

The two clones E460 and C946 have been included to show how productivity can be increased by topworking male trees.

At Nabomba another trial of new *montana* A-type clones has borne its first "fly" crop and M8 is, in this case, in the group of six best yielders.

The *fordii* selections at Namabinzi have not yet come into bearing.

A collection of crossed and selfed *montana* B-type seedlings and American and local seed of *fordii* selections, planted at Bvumbwe in 1952, has now begun to yield. Out of these, the *montana* seedlings from E464 $\times$ 14, 9 selfed and 14 selfed have produced the largest number of high yielders, i.e., over 10 lb. dry nuts per tree for the first crop.

2. Fertilizer Trials

2.1. N.P.K.

The experiment at Bvumbwe consistently shows an increase due only to 3 lb. of sulphate of ammonia per tree.

N.P.K. Trial at Bvumbwe
(Yield dry nuts, lb. per acre)

Experi- mental mean	Increase due to Nitrogen	L.S.D. P=0.01
1269	352	104

The overall yield was 62 per cent. greater than last year and the increase due to nitrogen was in the same order as last year. One pound of sulphate of ammonia given for the last two years to hithero unfertilized plots produced no increase in crop.

Similarly, the experiment on the Vipya showed a highly significant increase in yield due to nitrogen as against no nitrogen at all; there was no real difference between the levels of application. As is so often found with tung the application of potash led to a reduction in yield and aggravated dieback.

N.P.K. Trial at Mzuzu

	N ₀	N ₁	N ₂	N ₃
Yield per tree	12.5	20.0	17.4	21.4
Yield per acre	813	1300	1131	1385

N₀, N₁, N₂, N₃, = 0, 1, 2, 3 lb. sulphate of ammonia per tree respectively.

2.2. N.P.K. WITH COPPER AND ZINC

The results of the three experiments are tabulated below:

NPKCuZn Trial, yield per acre
(lb. dry nuts)

	Experimental Mean	Increase due to nitrogen	L.S.D. P=0.01
Bvumbwe	1,989	114	100
Gala	1,298	585	33
Mzuzu	1,898	424	137

In all experiments a response to nitrogen only is indicated in the yields, in spite of the fact that zinc is known to be deficient in the soils of two of them, i.e., Gala and Mzuzu. In the plots where zinc has been applied it can be seen by observation to clear all visual symptoms. The response to nitrogen is greatest, as might be expected, on the poorest soil, i.e., at Gala. Yet a significant increase to zinc (at $P=0.05$) has been recorded only at Bvumbwe when applied with N and P. Due to the past history of the experiment, the one at Mzuzu is not altogether satisfactory and is to be discontinued.

2.3. N.P.K. WITH DUNG

These experiments are to be discontinued since the application of dung is impracticable on a plantation scale.

Experiment at Gala

(Yield per acre)

Experimental mean	Increase due to			L.S.D.	
	N ₁	N ₂	D	P=0.05	P=0.01
964	406	139	139	124	166

N₁=3 lb. sulphate of ammonia per tree (237 lb. per acre) and

N₂=1 lb. sulphate of ammonia per tree

D.=100 lb. dry per tree (4 tons per acre).

Sulphate of ammonia has always produced more marked results than dung. It is also cheaper or as cheap to apply. The N₁ and D applications have been made since the experiment started in November, 1948. The N₂ application was made on previously unfertilized plots from 1955 onwards, i.e., after two applications there was a significant increase in yield. Therefore it can be inferred that tung, even if neglected in its early stages, will respond to fertilizer treatment subsequently; this is particularly true in the poorer soils on which tung is grown.

Observation plots on the Vipya, also to be discontinued, have shown that nitrogen produces a marked effect on the yield.

Vipya Observation Plots, 1953/57

(Mean yield per acre)

	Treatments				
	Nil	D	N	NP	N.P.K.
Mzuzu Poor Soil	176	403	377	748	962
Mzuzu Good Soil	1,112	1,125	1,541	1,469	1,918
Lusangadzi White Sands	982	1,073	1,950	1,768	1,060

Dung is of less value than inorganics, except in the case of the sandy Mzuzu Poor Soil. P (superphosphate) gives no results in good soil but a marked increase in yield in poor soil; this is the only case in which P has given an increase anywhere.

2.4. NITROGEN

The nitrogen fertilizer trial at Bvumbwe is to be discontinued. The responses for this season to 2, 4 and 6 lb. of sulphate of ammonia per tree have been similar to previous years (see table below) and may be compared with the experiment mentioned under 2.1.

Nitrogen Fertilizer Trial on Mature Trees

(Yield per acre of air dry nuts)

Treatment				L.S.D.	
0	N ₂	N ₄	N ₆	P=0.05	P=0.01
767	1,271	1,271	1,596	353	488

The two experiments on young trees show similar results to last year.

Nitrogen Fertilizer Trial on Young Trees

	Treatment								L.S.D.	
	Control 0	Tung cake lb./tree		Sulphate of ammonia lb./tree					P=0.5	P=0.1
		20	30	2	4	4*	6	6*		
Gala (6 years old)										
Yield per tree ..	12.1	12.7	15.6	14.1	20.3	20.6	16.3	17.6	4.9	6.6
Yield per acre ..	678	711	874	790	1,137	1,154	913	986	274	370
Nchima (4 years old)										
Yield per tree ..	3.6	6.3	6.9	7.2	9.4	9.0	9.6	8.9	3.0	4.1
Yield per acre ..	201	351	384	428	524	506	537	497	169	228

* Applications made as follows:

Gala—split applications in October and December,

Nchima—4 lb. applied in July

6 lb. applied as split applications in July and October.

All other applications are made in late October to November.

Sulphate of ammonia gives quicker results than tung cake containing an equivalent amount of nitrogen (20 lb. tung cake contains approximately the same amount of nitrogen as 4 lb. sulphate of ammonia). There seems to be little advantage in splitting the applications of sulphate of ammonia at Gala; it seems to be detrimental to apply early at Nchima or in split applications.

3. Other Tung Experiments

A dieback of shoots and premature fruit fall was reported in the 1953/54 Report. Subsequent investigations disclosed that it was confined to a potentially high-yielding A-Type clone A43. Fruit fall appeared to occur in two stages, i.e., soon after fruit set and from about six to eight weeks before normal fruit fall and onwards. The causes could have been physiological or pathological.

Evidence in favour of a physiological cause, e.g., low soil moisture at time of fruit set, was that fruit fall was less severe in 1955 when the October rainfall (period following fruit set) was above normal for the area. However, this would seem to be a contributory factor since the second stage of fruit fall occurred after the main rains had started. The nuts, which fell about six weeks before the normal time, contained 45 per cent. oil (60–65 per cent. in mature nuts) and two weeks later 52–53 per cent. oil.

Attempts were made to stop the abscission layer forming by spraying with -naphthalene-acetic acid at the normal, three times (3N) and six times (6N) normal strength and at varying times and frequency. 3N had some and 6N had a marked effect in arresting fruit fall but the normal strength had no effect.

Growth was, however, abnormal, a proliferation of buds occurring along the young stems particularly at terminal points; secondary growth also occurred after fruit fall. Thus there was a strong suggestion of some pathogen and a virus was suspected. Buds were worked on stocks at Bvumbwe and the young scions arising therefrom are showing similar symptoms. The investigation continues.

Tung Oil

1. STATUTORY ANALYSES OF EXPORTED OIL

Sixty samples from 862 tons (840 tons *montana* and 22 tons *fordii*) were examined. The distribution of exports was 409 tons to Europe, 196 tons to U.S.A. and 257 tons to Africa.

The range of constants obtained was as follows, the most significant point probably being the maintenance of very low acidity throughout the season. All but one of the shipments had an acidity of less than 0.9 per cent. compared with the maximum permissible figure of 2.5 per cent. The exception was a small (5 ton) consignment of *fordii* oil, the acidity of which was 1.6 per cent. This was traced back to unsatisfactory storage of seed on one estate.

				<i>Montana</i>	<i>Fordii</i>
Volatile matter per cent.	..	..	..	0.04-0.18	0.05-0.06
Specific gravity at 15.5°C	..	..	..	0.936-0.939	0.940
Refractive Index at 20°C	..	..	..	1.513-1.515	1.522
Iodine value	..	..	..	158-168	170-173
Saponification value	..	..	..	190-194	193-194
Acidity (as oleic acid) per cent.	..	..	..	0.36-0.92	0.63
Unsaponifiable matter per cent.	..	..	..	0.31-0.67	0.25-0.26
B.S.S. Heat Test Mins.	..	..	..	23½-26½	14½-15
Worstall „ „ „	..	..	..	13½-15½	7½
A.S.T.M. „ „ „	..	..	..	16-18	—

The figures for the heat test can be split into two groups—i.e., the Cholo and Zomba oil, the cause of this local variation being discussed in last year's Report. The B.S.S. heat test for the *montana* oil can thus be given as 23½-25 mins. for Cholo, and 24½-26½ for the Zomba area. It appears that oil from both areas shows a rather higher gelation time this season.

2. TUNG OIL CONTENT

(a) Owing to the leave of the Agricultural Chemist for part of the year the only samples examined from fertilizer experiments in the 1955-56 crop were from the Vipya (Northern Province) and gave the following results:—

<i>Treatment</i>	<i>Sulphate of Ammonia</i>	0	2 lb.	3 lb.	
Percentage oil		67.6	65.1	64.9	—

Whether these differences might be due to the more vigorous growth on the S/A plots causing a strain on the potash supplies cannot be concluded and a wider range of samples has been taken from the 1956-57 crop.

(b) The oil content of prematurely fallen nuts was determined and found to be 45 per cent., instead of the 60-65 per cent. found in fully mature nuts. Two weeks later, the oil content was found to be 52-53 per cent. both in stored and freshly collected seed.

Extract from Plant Pathologist's Report

During the course of the year an investigation was made into the high incidence of *Amillaria mellea* (Fr.) Quel, on tung in the Northern Province. This disease in some fields of the Vipya tung estates causes up to 15 per cent. loss in stand. A study of the history of the fields concerned showed that an insufficient period was allowed to elapse between ringbarking and clearing; clearing with a tractor and chain tended to snap some of the trees off at soil level, the stumps thereafter forming *foci* of infection and finally after clearing, the timber was stacked in windrows which allowed infection of the still green wood by *Armillaria mellea*, from which it spread to the growing tung.

Dieback, caused by *Botriosphaeria ribis* (Gross & Dugg.), is still common where tung is neglected, but if rigorous control measures, as suggested by Wiehe, are adopted, the disease causes no loss.

COFFEE

1. Cultivation and Manurial Experiments

The experiment at Namingomba yielded its second crop and that at Bvumbwe its first crop. The experiment at Gala produced no crop, having gone into 100 per cent. biennial bearing through overcropping the previous year; it had been pruned to the single stem system.

Comparative data for Three Shade/Mulch Experiments

<i>Treatment</i>	<i>Yield clean coffee (lb. per acre)</i>		<i>Mean girth in c.m.</i>
	<i>Bvumbwe</i>	<i>Namingomba</i>	<i>Gala</i>
M. No Shade; mulched	815	1,039	17.4
S.M. Leguminous Shade; mulched	104	1,108	17.1
(1) Non-leguminous Shade; not mulched*	82	684	17.9
S.Leguminous Shade; not mulched*	40	861	16.6
L.S.D. $P=0.05$	711	441	not sig.
0.01	766		

* Except at Bvumbwe where (1) is mulched with cut Napier and S is mulched with tung hulls.

Mulch at Naming'omba consists of tung nut shells from the factory, at Gala of tung hulls and at Bvumbwe of cut Napier.

In these experiments the importance of mulch is again emphasized. At Bvumbwe (50 inches rainfall) the yield figures are even more strongly indicative of the treatment differences than the girth measurements published last year; the effect of the temporary shade has been to retard seriously the growth of the trees in those plots, although the shade was removed and mulch applied over a year ago. At Namingomba there were several complicating factors—(i) death of some trees by ringing with a chrome paint, (ii) further casualties due to attacks by *Fusarium* dieback disease, and (iii) the cutting down of some *grevillea* shade trees by local vandals in plots (1). When corrections are made for vacancies and supplies, the treatment differences are significant. It can be inferred that at Namingomba (60 inches rainfall) the effect of shade will not be detrimental; thus a light shade of *albizzia* appears to be beneficial in those areas enjoying a higher rainfall, provided mulching is also done efficiently. At Gala there are no significant differences, complicating factors producing errors in the experiment being (i) pruning to a single stem system when the double stem system was intended and (ii) the late establishment of shade trees.

Dieback after cropping is an important factor, since it may be an indicator of the general condition of the tree and its potential for cropping next year. Therefore prunings made after cropping were weighed at Bvumbwe and at Namingomba.

Total Prunings of Dieback after Cropping (gm.)

<i>Treatment</i>	<i>Bvumbwe</i>	<i>Namingomba</i>
M	321	7,333
SM	401	7,815
(1)	896	4,975
S	755	3,906

Although there were no significant differences in pruning weights, due to the treatments, those at Bvumbwe do reflect the results from the yields of coffee due to treatment, in that the best yield and least dieback is to be found in the mulched plots. At Namingomba no importance can be attached to the figures due to the complicating factors already mentioned.

The experiments at Bvumbwe and Namingomba also showed some responses to fertilizer treatments. At Bvumbwe the response to nitrogen was not significant, only the interaction PK reaching significance, but sulphate of ammonia (200 lb./acre) gave a very significant increase in yield with mulch, no shade, i.e., treatment M. (*see* table below). At Namingomba there was an increase of yield due to 200 lb. of sulphate of ammonia and a smaller increase due to 200 lb./acre of superphosphate. Sulphate of ammonia gave a very significant increase in yield with the *Albizia*-shade plots both mulched and non-mulched, i.e., SM and S treatment (*see* table below).

Treatment X Fertilizer Interaction

(Clean coffee. lb. per acre)

Treatment	Bvumbwe		Namingomba*		200 lb./acre supers
	No Fertilizer	200 lb./acre S of A	No Fertiliser	200 lb./acre S. of A.	
SM	430	413	726	1,237	1,210
(I)	191	114	511	511	619
M	1,644	1,895	888	915	1,372
S	Nil	70	699	1,264	726
L.S.D. for interactions ..	—	—	—	—	—
P=0.05	81	—	166	—	—
0.01	110	—	225	—	—

*Corrected for vacancies and supplies.

An N.P.K. manurial trial was planted on the Vipya this season. Growth and establishment was, however, poor.

In the Bvumbwe experiments the average hulling loss was 25.8 per cent. and the mean cherry to clean coffee ratio was 6.3/1. This ratio is on the high side because it was not possible this year to separate out unfilled cherry ("floaters").

2. Variety Trials

Small plots in the guard rows of the experiments planted in 1953 at Bvumbwe have yielded their first crop. Yields of clean coffee expressed in lb. per acre were as follows:—

Preliminary Observation Plot: Coffee Selections

Variety	Yield per acre		Percentage Good Cherry
	Clean coffee	Mbuni	
Brazil	1,028	333	94.8
N81	952	236	95.2
N197	936	150	97.5
H66	791	317	93.0
L1	732	230	95.5
KP162	560	483	89.8
N39	457	230	92.4
KP423	436	139	95.1
N5	267	150	90.9

KP162 ripened its crop later than the other varieties and therefore much of its crop had to be picked green and consequently classed as *mbuni*; this accounts for the low percentage of good cherry. Brazil had a very long ripening period and again a higher proportion had to be picked green giving a higher amount of *mbuni* than other varieties.

It is, however, premature to judge a variety on one year's yield. Dieback and leaf fall after cropping will affect the following season's yield. This season has been exceptionally dry and the coffee has been placed under unusual stress. Thus much leaf fall and subsequent dieback was noted in N81 and less in N197, whereas N39 and N5 suffered very little from leaf fall.

Records of dieback prunings made after the crop was harvested gave the result in the table below.

Dieback Prunings

Variety				Weight prunings (gm)
Brazil	..	..	..	287
N81	..	..	..	1,225
N197	..	..	..	671
H66	..	..	..	117
L1	..	..	..	1,960
KP162	..	..	..	385
N39	..	..	..	350
KP423	..	..	..	1,395
N5	..	..	..	632

This table shows that there is no relation between the yield and the amount of dieback. There was very much more dieback in variety N81 than in Brazil or N197, though there was little difference in yields of these three varieties. It is possible that the large amount of dieback in N81 may indicate a tendency to overbear and it remains to be seen if a high yield will be given next year.

Variety trials planted at Bvumbwe, Gala and Namingomba have not yet come into bearing. A fourth trial has been planted this season on the Vipya, where zinc deficiency was as marked as on the tung.

Girth measurements were taken of the non-bearing coffee in the belief that they could serve as an indication as to how a variety is growing. There were significant differences in the growth rate of the different selections at the different localities. It remains to be seen whether this can be taken as a preview of cropping performance. At this stage it can only be stated that those which have grown consistently well are, N39, N81, KP162, KP423, S.L.14, S.L.28 and Brazil.

In all the experimental plots the coffee is being grown on the multiple stem. Routine control measures against stem borer with dieldrin have been adopted. *Antestia* bug has been controlled by spraying with DDT or dusting with pyrethrum. There was no sign of fruit fly, although on a non-experimental plot it was seen to be causing the premature ripening of the cherry. The dieback disease, *Fusarium lateritium longum*, has resulted in widespread casualties in Cholo District and is promising to be a disease of major importance. It appears to attack coffee which is not growing in ideal conditions but studies on the nutritional status of the trees (see Report by Chemist) have yielded little. It was noticed at first that the disease attacked only trees which had been in bearing for some years, particularly those which were subjected to drastic pruning, e.g., on conversion from single stem to multiple stem system. However, seedlings planted out near Bvumbwe have succumbed to the disease. This disease is the subject of further investigation, being conducted jointly by the Bvumbwe Station, Pathologist and Chemist.

Foster, L. J. and Craske, G. F.—Coffee Growing in Nyasaland.

—I *Nyasaland Farmer and Forester* 3 (2), 1956.

—II " " " " 3 (4), 1957.

Extract from Report of Agricultural Chemist, Bvumbwe

In the Southern Province, a zinc deficiency was reflected in contents of 12 and 29 p.p.m. in the affected and normal leaves. The deficiency, however, was only mild as the symptoms disappeared with the onset of the rains.

A more important study of coffee nutrition has commenced because of the increased incidence of *Fusarium* dieback. It appeared that this might be related to the increased age of the trees, which in turn might be reflected in the gradual depletion of some particular nutrient. Two affected areas were therefore compared with an adjoining plot of bushes, free from disease. The composition of the respective leaves was:—

	<i>Affected Coffee Leaf</i> (8 years old)		<i>Affected Trees</i> (14 years old)		<i>Satisfactory Trees</i>	
	<i>New Leaf</i>	<i>Mature Leaf</i>	<i>New Leaf</i>	<i>Mature Leaf</i>	<i>New Leaf</i>	<i>Mature Leaf</i>
Ash per cent.	8.1	8.8	7.1	7.1	7.8	8.7
Nitrogen per cent.	3.61	2.97	3.13	2.77	3.68	3.07
Phosphate (P) per cent.	0.26	0.22	0.26	0.19	0.26	0.23
Potash (K) per cent.	1.96	1.80	1.80	1.80	1.87	1.48
Calcium per cent.	0.68	1.05	0.57	0.62	0.68	1.29
Magnesium per cent.	0.61	0.71	0.58	0.39	9.45	0.75
Copper p.p.m.	17.2	32.8	11.4	16.8	18.0	19.4
Zinc p.p.m.	49.2	24.0	15.0	27.2	24.0	18.6
Boron p.p.m.	82	102	47	88	76	131
Iron p.p.m.	210	140	135	70	120	100
Manganese p.p.m.	56	152	58	80	64	136

From these figures, there is little difference between the contents of the macro-nutrients, except that the 14-year-old affected trees are rather lower in N, and Ca, but as the other affected trees contain higher levels of these nutrients, this does not afford an explanation—particularly as the levels are above those normally considered satisfactory for coffee.

Regarding the micro-nutrients—the copper and boron contents of some affected trees are rather lower than the satisfactory trees—but again this possible explanation is counterbalanced by the evidence of the eight-year-old trees, which contain higher and satisfactory amounts as judged by recognized levels. In any case, any possibility of copper deficiency would have been rectified by the copper fungicidal sprays which have been applied.

An instance of the acidifying action of ammonium sulphate was encountered in the investigation of the coffee dieback in the Misuku area of the Northern Province. As yellow leaf symptoms had suggested nitrogen deficiency, ammonium sulphate was

applied, but this only accentuated the leaf fall. Samples of these leaves, together with more normal leaf, were therefore examined, the results being shown below.

	Yellow	Yellow plus S/A	Normal
pH of soil 0-6"	5.4	5.0	5.8
6-12"	5.2	4.9	5.4
Av. Wt. of leaf (gms)	0.35	0.25	0.60
Ash per cent	5.46	8.58	6.51
N per cent	1.83	3.08	2.52
P.	0.22	0.29	0.55
K.	1.33	1.72	1.40
Ca.	1.10	1.08	0.76
Mg.	0.37	0.48	0.31
Cu. ppm.	11.9	10.6	22.6
Zn.	15.5	6.2	20.1
Mn.	212	515	185
Al.	420	395	275
Fe.	220	362	192

The pH of the soils is also shown as this was the only point on which they differed greatly. The organic carbon varied from 2.3-3.5, the K from 0.6-0.9 and the P from 13-31 p.p.m., the nitrogen was 0.14-0.28 per cent. Laboratory tests confirmed that the change of pH as indicated could occur with the 2-4 oz. dressings that had been used. As the soil samples were taken six months after fertilizer application, even more drastic localized pH changes may have been caused and contributed more to the nutrient imbalance that has caused the scorching than is shown by the above figures, clear though it is that even these show the wide difference in nutrient uptake caused by pH alteration. The use of alternative sources, e.g., sodium nitrate, urea, or occasional liming of the soils, is now being examined.

Similarly a lower soil pH would appear to induce zinc deficiency in coffee in the Vipya area, where leaf analysis indicated the main difference to be in the zinc content (8.5 p.p.m. in the affected leaf against 14.7 in the satisfactory leaf).

Extract from Plant Pathologist's Report

Hemileia vastatrix (B. & Br.). During the course of the year, this fungus caused severe defoliation in coffee gardens in the Misuku Hills, three peaks of infection, in November, 1956, in February and in June, 1957, being recorded. During a visit to the area in July, seedlings were found under rusted coffee bushes bearing sporing lesions of *H. vastatrix* on the cotyledonary leaves.

Cercospora coffeicola (B. & C.), attack resulted in defoliation in several nurseries in the course of the year. If control measures were not observed, the disease persisted in the field on transplanted seedlings, causing defoliation.

Fusarium bark diseases. Two apparently distinct diseases of coffee are caused by very closely related species of *Fusarium*, if not different strains of the same fungus, *Fusarium lateritium* var. *longum* Wr. (*Fusarium stilboides* Wr. forma). In the Northern Province this disease takes the form of a "collar rot" from which the plants die. Affected plants appear to be unthrifty, the leaves having a yellowish cast. Closer examination reveals a constriction in the stem, or a flattened lesion on one side of the stem leading to a sometimes indistinct "collar" some 4-8 ins. above the ground, where callous tissue has evidently formed, growing down over the infected part. Scraping away the bark from one of these flattened lesions will reveal dead brown tissue beneath instead of the normal healthy green. Affected trees invariably die, and young replants growing in recently vacated planting holes succumb rapidly.

In the Southern Province the disease takes the form described by Storey from East Africa in *Ann. Appl. Biol.*, XIX, 173. This disease was first described from Nyasaland in 1934 by Leach (*Ann. Rept.*, Dept. of Agric., 1934) his diagnosis being verified by the I.M.I. (*Ann. Rept.*, 1935). Since then the disease appears to have been confined to a small area in Cholo, where recently it has been doing considerable damage to some eight-year-old coffee being converted to multiple stem pruning from single stem. Some work is being done on this disease in an attempt to elucidate the life-cycle of the pathogen, on which it is hoped to base recommendations for its control.

Armillaria mellea (Fr.) Quel. Coffee in Nyasaland still appears to maintain its resistance to this pathogen, no cases of deaths due to *A. mellea* having been recorded, even when interplanted in tung which was being killed by the disease.

Extract from Report of Entomologist

In much of the Northern Province it is now general practice to paint the first eighteen inches of stem with an emulsion of dieldrin, on the lines recommended by Tapley in Tanganyika. This treatment is most effective and has resulted in excellent control of the white stem borer (*Anthores leuconotus* Perc.), particularly in the Misuku Hills of Karonga District. White stem borer has made its appearance in other areas where coffee growing has started, such as the Nkata Bay District. It is hoped that treatment of coffee bushes with dieldrin will become standard practice throughout the Protectorate.

The Cameron bug (*Antestia variegata* Thumb) is becoming a problem on coffee in the Southern Province. An outbreak in Zomba was successfully controlled with 5 per cent. DDT Dust at 20 lb. per acre.

FRUIT

DECIDUOUS FRUITS

This winter has been exceptionally dry and warm at Bvumbwe, the average minimum temperature for June and July being about 5°F, higher than normal. Thus the deciduous fruits showed more marked symptoms than usual of prolonged dormancy. Varieties most affected were Van Riebeeck peach and Shiro plum; they have had to be discarded as unsuitable.

Plums were sprayed six weeks before normal bud burst with either a 5 per cent. D.N.O.C./oil emulsion or a straight D.N.O.C. spray. Within three weeks the advantages of spraying with the D.N.O.C./oil emulsion were obvious. Bud burst was even, nearly all flower buds opening within a few days of each other on a given variety; unsprayed trees remained dormant for another three weeks and bud burst was spread over a longer period, many buds failing to open altogether and eventually dying.

Yields of fruit trees were as follows:—

Mean Yield per Tree (lb.)

Variety	Bvumbwe 3,880'		Mwera Hill 4,800'		Nchenachena 3,800'		REMARKS
	Age	Yield	Age	Yield	Age	Yield	
Peaches: Angel	3	42	10	74	6	34	
Killiekrankie	3	11	10	46	6	169	
Waldo	3	11	10	83	6	196	
C.O. Smith	2	—	7	23	—	—	
Plums: Santa Rosa	3	} Few fruits	8	11	6	38	
Satsuma	3		8	8	6	42	
Guavas: Parkers' White ..	3	94*	10	40	—	—	
Patnagola	3	84*	10	36	—	—	*Much of this fruit badly marked by fruit fly and dis- carded.
Keerweder	2	31	—	—	—	—	
Fan Retief	2	35	—	—	—	—	
Loquat	3	9	10	4	5	68	Low yields at Mwera Hill due to biennial bearing and loss of fruit to birds.
Mulberry	3	30	10	9	5	2	Low yields at Mwera Hill and Nchenachena due to need for pollard- ing.
Tree Tomatoes: Red	3	28.4	4	16	—	—	
Yellow	3	24.0	4	50	—	—	
Local	—	—	11	43	—	—	

In addition to those varieties enumerated in the 1954/55 Report the following have proved unsuitable to Bvumbwe conditions:—

Almonds: all varieties.

Peaches: Brook, Van Riebeeck, Elberta.

Plums: Shiro.

Grapes: Alphonse Lavalle (probably too wet for grapes here).

The white guavas, although good yielders, have not proved popular on the local market.

Records have been made of times of flower and leaf bud break, leaf fall and growth in terms of trunk girth, total height and spread.

The table below summarizes the growth rate that might be expected in the Bvumbwe area for the four most promising varieties of peaches and plums.

Growth Rate of Peaches and Plums
(Annual Growth of 3½-year-old trees)

Variety				Girth (cm.)	Increase over last year	Height	Increase over last year	Spread	Increase over last year
Peach:	Angel	..	..	34.7	6.8	4.1	1.0	3.6	0.7
	Killiekrankie	..	..	26.8	6.7	3.9	0.7	3.0	0.9
Plum:	Santa Rosa	..	..	17.9	4.4	3.2	0.6	1.6	0.4
	Methley	..	..	22.3	8.8	3.2	0.5	2.3	0.4

Irrigation has increased the growth rate (as measured by girth), e.g. Killiekrankie peach produced an increase in girth of 7.5 cm. for an irrigated tree and 3.5 for a non-irrigated tree.

The following varieties have made the most promising growth:—

Of the peaches: Angel, Kakamas, Killiekrankie, Waldo, Alpha Supreme, Beauty of Booradabin, Shackleford.

Plums: Burkbank, Kelsey, Santa Rosa, Satsuma, Jardine's Early, Gaviota, Methley.

Guavas: Fan Retief, Malherbe, Keerweder, Parker's White, Patnagola.

Avocadoes: Collinson, Fuerte, Itzamna and Gottfried.

Poor growth, in the case of deciduous fruits, does not usually indicate dwarfness or precocity but may generally be taken as an indication of adverse conditions, prolonged dormancy being very much evident.

Fruit fly has become a serious pest and control measures have had to be taken. Birds have also caused some trouble, particularly with peaches, plums, strawberries and mulberries. Peach rust caused early defoliation this year and this is probably a cause of the out-of-season flowering that was so widespread in April/May. Peach leaf curl was also serious enough to warrant spraying with Bordeaux mixture. Two plums and two peaches were lost by *Armillaria* attack, in spite of the fact that all indigenous trees were ring-barked two years before removal.

STRAWBERRIES

A variety trial was planted at Bvumbwe in March in a 7 × 7 Latin Square. Plants are in double rows 3 feet apart with a spacing of 9" × 18", the land manured with FYM at a rate of 15 tons per acre prior to planting and top-dressed with 200 lb. superphosphate per acre worked in at time of planting. The experiment was irrigated regularly by overhead sprinklers. Blossoms were removed until 1st June; the first crop was harvested on 9th July. The size of fruit was excellent for the first two months. Bearing will continue until the rains, so full results cannot yet be given. The earliest varieties are Cambridge 449, Melba and Nankhunda with the yield in that order. They are, therefore, the most valuable varieties. Cambridge Early Pine starts cropping early in August.

Vigour, in terms of spread, was measured two months after planting and this seems to be related to cropping capacity. The table below shows the final figures for the yields 1955/56 which were too late for last year's Report.

Strawberry Growth and Yield

<i>Variety</i>				<i>Mean spread D. cm.</i>	<i>Yield per acre (lb.)</i>
Cambridge E.P.	..	...	..	2.28	3924
Melba	..	..	..	1.99	3782
Cambridge 449	..	..	..	1.90	2700
Nankhunda	..	..	..	1.80	2133
Salisbury	..	..	..	1.66	1217
Katete	..	..	..	1.61	1490
Vumba	..	..	..	1.60	1062
L.S.D. 5 per cent. level	..	..	..	0.40	—
1 per cent.	..	..	..	0.54	—

Plants were in double rows 3 feet apart at a spacing of 18" × 18".

A manurial irrigation trial was also planted at the same time with the varieties Melba and Cambridge 449. The spacing was wider being 18" × 18". Results will be published in next year's Report.

GRANADILLAS

The experiment planted at Bvumbwe in December, 1954, and reported in previous years, had yielded its second full crop by July, 1957, and the following conclusions may be drawn from the results over the whole period.

(i) *Fertilizers.* During the first six months sulphate of ammonia at the rate of 2/3rds lb. per plant, applied in split applications at planting time and late February, resulted in healthier plants and greener foliage and a significant increase of crop (at 1 per cent. level). Later, eighteen months after planting, sulphate of ammonia had a smaller effect although the rate of application had been increased to 1 lb. per plant (in split dressings—August/September and February/March,) and by July, 1957, the yield was actually less than the unfertilized plots although not significantly so. Superphosphate at the rate of 2/3rds lb. per plant (200 lb. per acre) applied immediately after planting had no effect. The fertilizer was not placed but was worked in the soil around the plant. Superphosphate at no time showed an effect, although proper placement of the fertilizer at planting time may be beneficial for ready establishment.

Whole fruits were analysed by the Chemist to assess the nutrient uptake of the plant. For every 1,000 lb. of fruit obtained it was estimated that the following nutrients were removed.

10 lb. N, 3 lb. P₂O₅ and 5 lb. K₂O

Therefore at 5 tons per acre the consumption of nutrients would be 100 lb. N, 30 lb. P₂O₅ and 50 lb. K₂O.

The dressing of 1 lb. sulphate of ammonia per plant (i.e. 63 lb. N per acre) cannot therefore be considered excessive.

(ii) *Training.* The first vines to come into bearing were those on the vertical type of trellis. This was to be expected since the vines had to climb only 3 feet to the first wire. After the first year the horizontal (two parallel wires at 6 feet from ground level) type of trellis was significantly better than the vertical (at 5 per cent. level) but by July, 1957, the yield, although better, just escaped significance both for the pruned and unpruned plots.

(iii) *Pruning*. Pruning the droppers to 12 inches at the end of the heavy summer crop resulted in severe attacks of *Fusarium oxysporum*, the disease attacking the vine near ground level. It appears that the main stem of the vine cannot stand exposure and severe sunburn results. The *Fusarium* probably entered as a result of the weakened condition of the plant. It quickly spread through all the pruned vines, causing 98 per cent. casualties. There were also some deaths due to *Armillaria mellea* root disease. Pruning at the end of the winter crop is not desirable, since the flowers for the summer crop have already appeared and the risk of sunscorch would be even greater. Therefore, it can be concluded that the only safe measure is to trim up the droppers to a height of two to three feet from the ground, thinning-out the number of droppers as necessary. Some pruning appears to be desirable since in a heavy curtain of droppers the stink or Bow-legged Bug (*Anoplocnemis curvipes*) causes a considerable amount of damage to the maturing fruit.

There was some chlorosis and rosetting of leaves during the dry season, due to drought conditions causing a temporary shortage of nutrients, most likely zinc and nitrogen, which quickly cleared up with the rains.

Mean yield in the first year for the unpruned plots was 6.25 short tons per acre. In the second year the yield was 6.05 tons per acre. The pruned plots gave only 4.5 tons. From the yields obtained it can be concluded that growing conditions at Bvumbwe are ideal for granadillas and this was confirmed from plantings nearby. Growth was excellent and there were no cases of woodiness virus. But following investigations made by the Chemist (*see Report*) on unthrifty vines planted outside the Bvumbwe area it was apparent that the crop will be unsatisfactory in conditions of poor soil, high temperature and very high rainfall.

Extract from Report of Agricultural Chemist, Bvumbwe

CITRUS

Several instance of leaf mottling and dieback were reported—but the most important example was on the main estate in the territory, where production had dropped to about one half of that in 1954.

The symptoms were as follows:—

Dieback at the extremities of the branches; yellow interveinal mottling of some leaves similar to that reported as manganese deficiency in other countries; chlorosis of leaves—with similar changes in the leaf representing nitrogen deficiency; from these trees or at least in the same area, the oranges develop brown and hard skins, although the inside of the fruit is quite satisfactory and unchanged

Leaf and soil samples from the affected area were examined, as also were leaves from an apparently satisfactory area further up the hill.

(a) THE SOILS

The analysis of the soils gave the following information:—

(i) The soils are slightly acid loamy sand top soils overlying soils of slightly higher clay content with depth although, even at three feet, this is only 20 per cent. They would therefore be of low moisture holding capacity.

(ii) Organic matter and nitrogen status is low to medium, the higher figures being found where grass mulch has accumulated.

(iii) Phosphate supplies appear satisfactory, but the potash level is rather low, the unaffected area having a higher potash status in the soil.

(iv) Although the affected area is rocky (several auger borings at random did not reveal any solid underlying rock) it appears that the surface rocks are not a problem, once the trees have developed their deeper root system.

(b) LEAF ANALYSIS

Typical affected leaves were analysed and the results were as follows:

	N <i>per</i> <i>cent.</i>	P <i>per</i> <i>cent.</i>	K <i>per</i> <i>cent.</i>	Cu	Zn <i>p.p.m.</i>	Mn
Yellow mottled leaves	2.17	0.46	2.03	20.8	16.3	11.2
Green leaves from same trees ..	2.23	0.43	2.03	14.0	16.3	15.5
" " " trees showing less mottling ..	2.27	0.69	2.52	18.5	12.5	8.0
" " " trees showing no mottling ..	2.24	0.42	2.1	9.8	21.3	15.9
Chlorotic leaves	1.41	0.61	1.12	25.0	8.8	7.2

Apart from the definitely chlorotic leaves, the cause of which is clearly lack of nitrogen, there is only slight variation in the composition of the other leaves as far as major elements are concerned. The copper content is higher in the mottled leaves than in the normal ones. The only marked contrast is in the figures for zinc, where the mottled and chlorotic leaves contain less than those from trees showing no mottling. Reported figures for the content of leaves showing zinc deficiency symptoms are 5–20 p.p.m., so it appears that even the trees where no mottling is found are on a marginal area. The figures for copper are somewhat anomalous. In tung it has been found that copper and zinc deficiencies occur together, whereas with this citrus the copper content of the affected leaves is higher than that of the normal ones.

The possibility of a zinc deficiency and/or incorrect Zn/N ratio receives support from the fact that tangerines examined from this area in 1955 had 5 p.p.m. Zn in mottled leaves and 20 p.p.m. in the satisfactory ones. Also the examination of similarly affected leaves from citrus on a Cholo estate showed concentrations of 8 p.p.m. and 10 p.p.m. in affected and apparently satisfactory leaves. It is interesting to note in this connection that it was on this Cholo estate than copper and zinc deficiencies were encountered on tung in 1950–1951, and the copper content of the citrus leaves (10 p.p.m.) is also low on this estate, and lower than at Neno. The fact that the manganese figures on the Cholo samples are higher than at Neno, also lends support to zinc being the main cause of the trouble.

In October the estate was visited again—after all the crop had been harvested, and while new growth was being made. Generally the trees looked much more healthy and chlorosis and mottling was far less prevalent. Leaf samples were again taken and following results obtained.

	N <i>per</i> <i>cent.</i>	P <i>per</i> <i>cent.</i>	K <i>per</i> <i>cent.</i>	Ca <i>per</i> <i>cent.</i>	Mg <i>per</i> <i>cent.</i>	Mn <i>p.p.m.</i>
Chlorotic leaves	2.14	.46	1.83	2.80	0.47	17.3
Healthy leaves	2.22	.36	1.64	1.40	0.57	20.0
Leaves from trees on anthill ..	2.95	.35	1.21	1.32	0.44	—

Nitrogen contents are similar to those obtained previously, but the potassium figures are lower. In both cases, the potassium figures would be regarded as satisfactory, and the higher ones obtained during the fruiting period may be due to insufficient nitrogen supply which had reduced vegetative growth. This view receives support from the fact that on the anthill, where the nitrogen supply is sufficient to give not only a much greener leaf, and a more dense leaf coverage, but also increases the N content of the leaf, the potassium content is lower, which indicates a greater spread of the nutrient available. The occurrence of small fruits in some areas may

also be due to locally restricted supplies of potash. It may also be noted that where N is available in nitrate form this tends to increase the K content above that where ammoniacal N is also present. Regarding trace elements, the indications were as found in the earlier samples, except that on the anthill sample the copper content was rather lower than generally found, again suggesting that the higher concentrations of this nutrient were partly caused by lack of nitrogen.

Examination of the stream water used for irrigation showed that this was quite suitable and could not have influenced the dieback of the orchard. As nitrogen seemed to be the predominant problem, the use of higher dressings of cattle manure or of mineral fertilizers was recommended.

As a trial, about 400 lb. of kraal manure was applied to several trees, and these were examined in April. The colour of the leaf was much improved, as was also the general vigour of the trees. The appearance of the fruit was better and no browning was evident. Leaf samples showed a nitrogen content of 2.5 per cent., which is also an improvement. An observational trial using varying levels of nitrogen (chiefly as sulphate of ammonia) and cattle manure (to supply $\frac{1}{2}$ –1 lb. phosphate and potash) is now in progress.

(d) OTHER FRUITS, ETC.

Granadillas. An area of granadillas, suffering badly from dieback, was investigated. Soil pits demonstrated that growth was restricted because the site was on a *dambo* head, where the soils are of low water-holding capacity in the dry season. The heavier soils beneath restrict the root penetration and in some places this is further complicated by the presence of lateritic layers. These lower soils are also water-logged in the rains, with consequent poor aeration and development. The better plants were found in the higher areas and where the soils were more loamy. The effect of these soils on nitrogen uptake was reflected in the leaf composition, that of the worst and best estate leaves being shown against satisfactory leaves from Bvumbwe.

				N	P	K
Yellow (North Estate)	..	..		1.52	0.35	0.74
Green (South ")	..	..		1.98	0.30	0.62
Bvumbwe (for comparison)	..	..		3.27	0.44	0.69

Extract from Plant Pathologist's Report

PEACHES: Rust, due to *Puccinia pruni-spinosae* Pers. and mildew, caused by *Sphaerotheca pannosa* (Wallr) Lev. were both serious during the year, considerable defoliation and distortion being caused.

CITRUS: *Armillaria mellea* (Fr.) Quel caused further losses in the course of the year in one large orchard. It is hoped to limit the spread of the disease in this valuable orchard.

Leafspot, due to *Alternaria citri* Pierce, was rather more widespread than usual, probably due to the unusually heavy rains.

GUAVA: Leafspot, due to a species of *Pestalotia*, presumably *psidii*, was found to be fairly widespread. This fungus evidently forms a leafspot secondary to the angular leafspot caused by the feeding of the mosquito bug, *Helopeltis bergrothi*. Also found on the guava is algal spot, caused by *Cephaleuros mycoidea* Karst.

BANANAS: A fruit rot apparently due to conidial *Glomerella cingulata* (Stonem) Spauld and Schrenk is quite common. Banana leafspot, due to *Cercospora musae*, Zimm. seems to have disappeared from the area where it occurred in the Northern Province, and has not been reported from anywhere else in the territory.

AGRICULTURAL CHEMISTRY

Report of Agricultural Chemist, Bvumbwe

IRRIGATION PROJECTS

1. ELEPHANT MARSH SURVEY

Apart from the regular soil surveys and investigations made in connection with specific problems as already detailed, about three to four months was occupied in obtaining data on samples taken by the soil surveyors of Hunting Technical Services, who carried out this survey for the Consulting Engineers to the Shire Valley Project. The preliminary survey of the Marsh was described in the 1954-55 Report. This present survey covered an area of approximately 150 square miles, by 16 traverses $1\frac{1}{2}$ miles apart, with sampling points at every $\frac{1}{4}$ mile along these. 1,267 samples from 319 bores were taken. These were all examined for colour, salinity and pH, carbonate, with 120 samples from selected profiles being fully examined for texture, nutrient status, etc. In addition 63 samples of ground water from various bores, and also samples from the Shire River, were analysed. Full details of all this data are given in the report published by Sir William Halcrow & Partners. To complete this brief reference to the work the following assessment of the Marsh was made.

Land Class	1	2	3	6
per cent. of Marsh	18	56	26	0.06

The number of bores in which alkalinity or salinity was appreciable varied from 5-10 per cent. depending on the limit taken. Fifteen bores had pH9 in the first foot, and 24 had pH9 in the top two feet, and 45 had pH8.5 and/or salinity 0.3 per cent. within the top three feet. The maximum salinity of the ground waters was 5500 p.p.m., but generally figures were of the order 300-900 p.p.m.

2. PILOT RECLAMATION AREAS

(i) *Namichimba Site*

Following the main survey, Departmental staff surveyed an area near the confluence of the Namichimba and Shire, for a pilot reclamation area. 250 acres were examined on 200 yard grid with a view to locating 40-50 acres for experimental use. 135 samples from 35 bores were examined for chemical and physical characteristics. The textural classification was as follows:—

- (1) A sandy loam to light clay over a sandy loam to silty clay loam.
- (2) A loamy sand to clay top soil and immediate subsoil over heavier underlying soils.
- (3) As above, but with lighter top soils, or distinctive underlying sand horizon.
- (4) Heavy clays of low permeability.

The final mapping was done by a basic textural map with a transparent pH and salinity map superimposed. This was considered better than a classification map which combined both factors, as potentially good areas that would respond to amelioration can readily be observed.

It was clear that, within this area, the necessary plot could be obtained to cover the three main types of soil found within the Marsh area. In addition, it was also possible to incorporate a saline area of pH 9.5 at 2 feet with salinity of 0.3 to 0.5 per cent. throughout the profile. An investigation could thus be made of the changes in such a soil on drying out, and also to investigate methods of effective drainage and leaching for salinity control. Piezometer tubes were also sunk along the centre trace to measure changes in level and salinity of the ground water.

Subsequently, however, it was considered that the situation at the confluence might lead to a complete breakthrough of a new river channel through the proposed area. This was therefore abandoned and, as the decision had also been taken to breach the Liwonde Bund, an alternative site which could be readily protected and be easily accessible had to be found.

(ii) *Makwira Site*

Such a site was selected close to the main east bank road and near the preliminary embankment for the first phase. A rapid survey of 300 acres was completed on a 200 yard grid just before inundation reoccurred. Examination of 89 samples from 29 bores indicated that this gave a fair selection of soils to cover the Class I and II groups, but none of the very heavy clays as found at Namichimba are included. Also no alkaline or saline area was located.

The reflooding of the Marsh has raised the question of the validity of experimental results obtained on an empoldered plot in which the water table is high because of the flooded surrounding area.

An alternative would be presented by the Experiment Station at Makanga, which is adjacent to the Marsh and where irrigation experiments are already in progress.

(iii) *Makanga*

In October, 1956, the new irrigation area was examined—to assess any difficulties that might arise during irrigation—or which might be caused by exposure of unsuitable soils by levelling. The general pattern was of sandy loam to sandy clay loam overlying silty clay loams. Below this at a depth of from 30–60 inches, a horizon of fine sand is encountered, this being from 6–24 inches deep. As levelling would require removal of 12–24 inches of soil in some places, this strata would in effect occur nearer the top in such areas. It may, however, be noted that soils of this type, even with a rather sandy lower horizon, are classed as I and II in the Huntings Report. To see if this area holds a wider range of soils, especially the more heavy ones that occur throughout the Marsh, a further survey of Makanga is being made.

3. EFFECT OF BOREHOLE WATER

With the increasing use of bore-hole water on estates it was interesting to note that at Tuchila the use of water containing 140 p.p.m. of sodium on tobacco nurseries led to an increase in pH to 7.6, and the sodium in the soil increased to 15 per cent. It was interesting to note that the use of higher amounts of water (2 gallons as against $\frac{1}{2}$ gallon per square yard) led to a slightly lower salinity in the soil—due to its greater “flushing” action.

MICRO-NUTRIENT INVESTIGATIONS

GENERAL

Many of these have been referred to in the previous sections on nutrients studies, but in addition an appreciable amount of time has been occupied on the problem of tea fermentation, in which copper determinations have been predominant. (*See Tea Section*).

METHODS

Since the micro-nutrient division was established, a number of methods for the various elements have been examined. In some instances colorimetric methods have replaced earlier polarographic methods for a few elements—but it is expected that the new Mervyn Harwell Polarograph will give better resolution which will facilitate the introduction of a polarographic method for cobalt, and also to make the methods previously developed for iron and manganese more comparable in speed to the colorimetric methods.

10 gm. of ground plant material is ashed at 450°C., and then dissolved in 50 per cent. hydrochloric acid and made to 100 ml. 25 ml. are used for the estimation of copper and zinc by extraction with dithizone at pH 8.3. This extract is evaporated—prior to the addition of the ammoniacal base solution for polarography.

For aluminium, 10 ml. of the solution is used to form a complex with Solochrome violet R.S. dye—the change in height of the polarographic wave of the dyestuff being used to calculate the amount of aluminium with which it has been complexed.

To determine iron, 5 ml. of the original solution is reduced and complexed with *aa'*-Dipyridyl, and the resultant colour evaluated in a photo-electric colorimeter.

The manganese is determined colorimetrically by oxidation of 25 m. of the solution with periodate.

Molybdenum is determined by formation of the thiocyanate complex, and cobalt by reaction with Nitroso-R salt. For the estimation of these colours, the spectrophotometer has been found more sensitive and valuable than the ordinary colorimeter. Molybdenum and cobalt can be determined on 5 or 10 ml. aliquots of the original plant solution—but it has generally been found a separate ashing of a larger amount, e.g., 20 gm., is preferable.

The determination of boron requires a separate ashing of the plant material with lime, which has given better results than using sodium hydroxide. The ashed material is dissolved in sulphuric acid and the colour of the quinalizarin complex estimated in the spectrophotometer.

FEEDING STUFFS, ETC.

A number of locally available materials were examined for feeding value, and these together with the composition of various silages are given below:—

Per cent. Composition of Dry Material

	Ash	Oil	Protein	Fibre	Soil Carbo- hydrate
<i>Fresh Material</i>					
Granadilla Husks	7.4	2.1	12.5	39.8	38.1
Soya Pods	6.1	3.8	9.3	41.5	39.3
Banana Leaf	7.4	5.3	16.0	27.7	43.6
<i>Silage</i>					
Maize Stalk	5.1	2.0	5.1	23.2	64.6
Banana Leaf, Soya and Napier Fodder ..	15.9	4.7	13.9	35.4	28.1
Napier and Rhodes Grass	16.9	2.1	3.9	20.9	56.2
Rhodes Grass	15.6	0.8	7.4	35.6	40.8
Maize Stalk and Velvet Bean Leaf	12.7	0.8	6.9	31.9	47.7

The air dry fresh materials contained 10–12 per cent. moisture and the silages 77–81 per cent. as received.

MILK TESTING

Determination of the butterfat content of milk from the individual cows of the Bvumbwe herd may be summarized in the following ranges of figures obtained.

				<i>Morning</i>		<i>Afternoon</i>		<i>Daily Average Fat per cent.</i>
				<i>Yield</i>	<i>Fat per cent.</i>	<i>Yield</i>	<i>Fat per cent.</i>	
March	..	..	..	10-17 lb.	4.5-5.2	7.13 lb.	5.4-6.7	5.0-6.0
August	..	..	..	8-16 „	3.2-5.4	6.14 „	6.4-6.8	4.7-5.9

SOILS AND NUTRIENT STUDIES

There has been little added to the nutrient map given in last year's Report but several problems have arisen which have led to more detailed studies of specific areas. From this has again emerged the fact that because of localized differences, each area must be examined closely.

TOBACCO SOILS AND LEAF SHATTER

Two factors led to a fairly detailed study of the various soils on which flue-cured tobacco is growing in the Southern Province. Firstly, enquiries were constantly received from growers, to see how the Tobacco Research Board's fertilizer recommendations could be applied to their estates, as the Board base the fertilizer requirements on the texture of the soil only. The second factor was the reported increase in the incidence of leaf shatter on curing. This occurred in conjunction with satisfactory leaf, and thus could not be attributed to curing conditions—neither did it appear related to disease—although there appeared a tendency for the shatter to increase with greater intensity of leaf spot. As the shatter was therefore most likely a nutrient problem these two aspects could be examined concurrently.

Samples of shattered and satisfactory leaf were taken from six different estates, and analysed for macro- and micro-nutrients. The results are given in Table I. These show that the content of the micro-nutrients appear within the satisfactory range. Of the macro-nutrients, some of the calcium contents appear rather low, and some of the potash levels are low. However, the only consistent factor which varies with the incidence of shatter is the nitrogen content of the leaf, which is consistently higher in the poor leaf than in that which is considered satisfactory. Also in the shattered leaf, and sometimes in the more satisfactory leaf, the nitrogen level is above that usually found in good leaf (1.5-1.8 per cent.).

TABLE I
Tobacco Shatter Investigation—Composition of Satisfactory and Shattered Leaf
(Composition on Dry Weight Basis)

Estate (Condition of Leaf)	A			B			C			D			E			F			Average		
	Good			Fair			Poor			Good			Fair			Good			Good		
	Ref. No.	575	576	577	578	579	595	597	598	607A	607C	607D	621	618	620	619	651	652	1.98	2.80	2.55
Nitrogen per cent.	..	1.94	2.14	2.79	2.11	2.69	2.27	2.35	2.68	1.73	2.41	2.54	1.62	2.25	1.48	2.03	2.73	2.86	—	—	—
Phosphate (P) per cent.	..	.41	.44	.66	.65	.45	.31	.39	.32	.44	.48	.50	.33	.31	.36	.50	0.25	0.27	0.39	0.44	0.43
Potassium (K) per cent.	..	3.32	3.93	3.36	2.15	2.90	2.50	2.88	2.82	3.51	3.20	2.98	3.86	2.94	3.94	3.96	2.68	2.74	3.17	3.34	3.10
N/K Ratio	..	.55	.54	.88	.98	.92	.91	.82	.95	.49	.75	.86	.42	.76	.37	.51	1.02	1.04	0.68	0.70	0.84
Calcium (Ca) per cent.	..	1.62	1.38	1.72	1.38	2.69	1.84	2.74	2.76	.75	1.88	.82	.71	1.97	1.43	1.36	2.08	2.40	1.40	2.00	1.96
Magnesium (mg) per cent.	..	0.71	1.05	1.27	1.63	1.45	1.26	1.13	1.37	1.28	1.22	1.77	1.42	0.96	0.37	0.89	.84	1.02	0.66	1.13	1.22
Ca plus Mg/K ratio	..	.66	.62	.89	1.40	1.38	1.24	1.34	1.46	.58	.97	.87	.55	1.34	.41	.52	1.08	.81	0.85	0.93	1.04
Mg/K ratio	..	.20	.27	.38	.76	.51	.51	.39	.48	.37	.38	.59	.37	.66	.30	.43	0.31	.37	0.42	0.35	0.49
Copper (Cu) p.p.m.	..	7.0	TR.	6.2	20.2	9.8	6.6	13.2	5.4	5.8	25.0	19.0	17.2	20.2	5.8	7.0	15.2	19.6	11.11	19.1	12.5
Zinc (Zn) p.p.m.	..	26.0	26.4	56.6	42.0	61.6	21.0	51.0	50.2	36.0	59.2	71.0	47.2	79.6	39.6	55.4	38.2	36.0	35.7	45.5	58.6
Iron (Fe) p.p.m.	..	140	160	190	210	205	160	175	175	145	255	255	160	265	255	290	140	170	169	197	221
Aluminum (Al) p.p.m.	..	115	100	80	100	120	100	100	100	135	110	120	90	110	90	65	280	320	130	103	131
Manganese (Mn) p.p.m.	..	90	105	105	190	165	135	110	120	130	140	120	80	200	100	115	70	80	121	118	129
Boron (B) p.p.m.	..	26.0	26.0	32.5	29.0	30.5	20.0	22.0	19.0	24.0	26.0	27.0	29.5	29.0	18.5	22.0	38.0	22.0	26.3	24.7	26.1
Ca/B ratio	..	620	530	530	475	880	920	1,245	1,460	310	720	305	240	680	230	150	545	1,080	491	832	726
Sodium p.p.m.	..	.048	.044	.017	.016	.018	.046	.16	.06	.012	.017	.014	.014	.014	.016	.012	—	—	.025	.074	.023
Chlorine	..	0.58	—	0.82	0.52	0.86	0.89	0.72	0.63	0.24	0.94	0.79	0.84	0.65	0.22	0.28	—	—	0.55	0.83	0.67

As, generally, low amounts of nitrogen had been applied it was necessary to see how far the soils themselves would affect the crop. A survey of representative tobacco estates (including those from which the leaf samples were obtained) was made. 300 samples from 88 pits on 19 estates were examined. A comparison may be made from the table given below:—

Representative Tobacco Soils of Nyasaland

<i>Locality</i>					<i>Texture (per cent. clay + silt)</i>		<i>Nutrient Status</i>		
					<i>Top</i>	<i>Sub</i>	<i>N per cent.</i>	<i>P.p.p.m.</i>	<i>K.mge/ 100 gm.</i>
Limbe	Light	..	..	..	14-20	30-40	.02-.06	40-60	.2-0.5
	Heavier	..	..	..	30-40	50-55	.06-0.1	20-120	.4-1.0
Cholo	..	..	..	..	28-32	35-42	.05-.08	60-85	.4-0.8
Zomba	Light	..	..	..	10-15	10-20	.03-.05	} 20-80	.2-0.4
	Heavier	..	..	..	30-40	40-50	.05-0.1		.5-0.8
Zomba-Limbe	..	..	..	..	30	40-50	.04-.12	20-80	.4-1.3
Lunzu	Light	..	..	..	10-15	15-20	.05-.08	10-15	.1-0.4
	Heavier	..	..	..	20	30-40	.04-.11	10-40	.4-0.9
Mpemba	..	..	..	..	18-20	20-40	.05-.08	40-70	.3-0.7
Balaka	..	..	..	..	20-30	35-50	.05-.09	20-80	.3-1.0
Namwera's	Heavy	..	..	..	45-50	50-60	.07-.14	} 20-140	.3-0.8
	Average	..	..	..	25-30	50	—		
	Light	..	..	..	15	23	.03-.08		.2-0.4

From this it is seen that, for many soils, there is an appreciable increased heaviness in the immediate subsoil. This clearly will be detrimental where heavier dressings of nitrogen have been used on a basis of the texture of the top soil, for the nitrogen will then be held in the root zone, rather than being leached further down, as would happen if the soil were light throughout. Generally, Southern Rhodesia soils are much lighter throughout their depth than are Nyasaland soils. The nutrient status of Nyasaland soils is also higher than are those of Rhodesia, and although there is some evidence that there higher P and K content may facilitate the use of lower amounts of these fertilizers than in Rhodesia, further confirmation is being sought by experiments. As seen from the shatter investigations, the main factor is nitrogen and while, for most other crops, the level would be considered "low"—a subdivision may be made for tobacco soils, viz., .05 per cent. low, .05-.08 per cent. medium and .08 per cent. high. Generally, Rhodesia soils would fall in the "low" class, and many Nyasaland soils contain more than 0.1 per cent. nitrogen.

Thus nitrogen availability appears to be the dominant problem. In this, time of ploughing will probably afford the best control—but soil tests to fractionate the nitrogen and to assess its availability will be brought into use next season.

Report of the Agricultural Chemist, Chitedze

SOILS AND NUTRIENT STUDIES

1. FERTILIZER EXPERIMENTS

(a) *Maize*. The more comprehensive type of experiment initiated last season was laid down on ten sites in the Central and eight sites in the Northern Province. The soils were specially selected after analysis of a large number as being representative of a wide range of textural groups with considerable variation in available nutrient status. The data being collected from these experiments are continuing to provide the best means of correlating soil analyses with field responses to major nutrients. At the time of writing there would appear to be no direct correlation between total nitrogen percentage and responses given, and these would seem to largely depend on unfertilized

yield. However, a new method of determination is to be introduced next season which measures the amount of mineralizable nitrogen produced by different soils, and with this it is hoped to obtain a much closer correlation. With regard to phosphate, considerable progress has been made towards obtaining specific threshold values for maize, for certain of the methods of determination employed.

(b) *Tobacco*. Fourteen experiments of a similar type to those used for maize were put down on six European estates in the Lilongwe District and at Chitedze. Of these, seven were on Burley, and seven on dark tobacco. As with maize, sites were again chosen with a view to obtaining the greatest possible range of soils with regard to texture and nutrient status. While not all the experiments were fully completed (nine only) a great deal of useful information was obtained and quite definite trends were indicated in the responses of many of the soils to the application of nitrogen and phosphate, for both Burley and dark tobacco, and general fertilizer recommendations will now be greatly improved because of this.

(c) A considerable number of samples were also analysed in connection with experimental work in progress at other stations in the Central and Northern Provinces.

2. ADVISORY WORK

Some 75 samples were submitted for analysis from various sources, including local tobacco estates, land settlement schemes, Forestry Department experimental sites and agricultural plots. Two of these samples from Fort Hill were taken from plots in close proximity and showed very strikingly the influence of pH on the availability of soil nutrients, as shown in Table II.

TABLE II
Influence of pH on Availability of Soil Nutrients (Misuku)

Lab No.	Depth	pH	Texture			Per cent. N	ads P (NH ₄ F)	Available bases m.e. per cent.			T.E.B.	B.E.C.	Base sat. per cent.
			C.S.	F.S.	S.C.			K	Ca	Mg			
643	0-6	5.0	2	14	29 53	.166	54	.08	.50	.30	0.9	13.5	7
645	0-6	6.8	8	21	31 41	.210	207	.78	16.0	4.0	20.8	18.5	fully sat.

3. MISCELLANEOUS SOIL WORK

(a) Further sampling was carried out on specific treatments of the major rotation experiments at Chitedze in order to continue observations of changes in organic matter, nitrogen supplies and nutrient status. Some 142 samples were dealt with.

(b) In connection with Soil Survey of Nyasaland two series of soil profiles were examined for the Ecologist (*see* report of the Ecologist). One of the series was from Dedza Secondary School, where the moderately acid topsoils varied from sandy loams through sandy clay loams to clays, all overlying clays which lay close to the surface. The nutrient status was generally low for nitrogen, while phosphate (ads.P.) was extraordinarily high throughout all the profiles even to depths of over 7 feet. Potash supplies were from medium to high.

The other series was from Balaka, the slightly to moderately acid topsoils being largely loamy sands or sandy loams with only a slight increase in clay content with depth. Nitrogen status was poor, phosphate supplies from medium to high and potash medium.

(c) Examination of soils from areas in which a large percentage of "pops" have occurred in the groundnuts grown on them, have to date revealed nothing on analysis which would indicate lack of any of the essential major elements which might be a contributory cause to this condition. Investigations are to continue.

FERTILIZERS AND FEEDING STUFFS

During the season over seventy samples comprising silages, fodders, hays, maize products, etc., were analysed. Also a considerable number of fertilizers, manures,

composts, guanos, etc., were submitted. A few typical fertilizer analyses are given in Table III.

TABLE III
Typical Fertilizer Analyses

Lab. No.	Type of Fertilizer	Per cent. Moisture	Per cent. N	Per cent. P2O5	Per cent. K2O
169	F.Y.M.	2.3	.43	.29	.44
360	Fresh Droppings	63.4	1.54	.74	1.49
171	Compost (Manure + bedding + earth)	2.8	.53	.29	.49
172	Compost (Manure + bedding) . .	5.2	1.35	.85	3.27
184	Guano	—	5.42	1.35	.24

NOTE. Further work on Agricultural Chemistry will be found in the various crop sections.

SOIL PHYSICS STUDIES

A. SOIL MOISTURE STUDIES AT CHITEDZE

Investigations commenced last season were continued on the soil moisture relationships and moisture requirements of maize, groundnuts and tobacco compared with three types of fallow, namely, clean weeded (bare), shallow rooted cover (teff) and indigenous weeds (volunteer cover). The only major change in the experimental layout was the reversal of last season's maize and groundnut plots to counteract the effect of crop on crop.

GROWING SEASON (CROP REPORT)

Total rainfall received by the experiment during the season was 41.74 inches, this being considerably above the station average. Although rainfall in April was low (.59 inches), there were 0.64 inches early in May when all cropping had finished.

All crops and treatments developed well initially but late in March the experiment received a severe setback overnight, being overrun by cattle. This considerably reduced, and in one case (maize) destroyed, the yields, and effects on subsequent moisture storage are reflected in the results to some extent.

INSTALLATION OF GYPSUM BLOCKS

A second set of cylindrical gypsum moisture units was installed under bare fallow, volunteer cover and teff treatments to a depth of 6 feet, thus completing the two replicate profiles of blocks under each treatment mentioned in last season's Report. By so doing it was hoped to attain a more complete pattern of distribution and movement of soil moisture in the various profiles.

SOIL MOISTURE SAMPLING

This was carried out under all treatments to a depth of at least 6 feet, this covering approximately the root ranges of all crops. Sampling was at regular intervals throughout the season when indicated by the moisture blocks and an extremely comprehensive picture of moisture changes was obtained. Unfortunately, no accurate bulk density determinations were possible as the equipment necessary for this, though ordered months before, was not made available. In consequence the conversion of moisture sampling data into equivalent inches of water present under the various treatment profiles throughout the last two seasons, has had to be based on the rough bulk density determinations carried out previously. This may account for any apparent anomalies in the results.

RESULTS

At the end of two complete seasons studies a considerable amount of interesting information has been obtained showing the effects of the various treatments on moisture utilisation and storage, and also how closely similar the seasonal pattern appears to be for individual crops (*see* Table IV).

TABLE IV

Comparison of Moisture Storage and Utilization Effects under various Crop Treatments at 0.3 ft. and 3-6 ft. Levels at the end of 1955/56 and 1956/57 Wet Seasons

Measurements	Maize		Tobacco		Maize		G-nuts		Bare fallow		Teff		Volunteer cover	
	June 1956	May 1957	June 1956	May 1957	June 1956	May 1957	June 1956	May 1957	June 1956	May 1957	June 1956	May 1957	June 1956	May 1957
Actual ins. water in 0-3 ft. profiles	9.45	9.38	9.06	8.55	8.62	7.77	7.94	8.22	7.74	7.73	7.00	7.51		
Actual ins. water in 3-6 ft. profiles	9.75	10.19	9.18	8.91	9.02	8.69	8.75	9.13	8.92	9.07	6.89	8.67		
Calc. ins. water in each 3 ft. of profile at F.C.	11.01			11.01		11.01		11.01		11.01		11.01		
Calc. ins. water in each 3 ft. of profile at W.P.	6.84			6.84		6.84		6.84		6.84		6.84		
Calc. ins. available water between F.C. and W.P. for each 3 ft. of profile	4.17			4.17		4.17		4.17		4.17		4.17		
Actual ins. available water remaining under each 0-3 ft. profile ..	2.61	2.54	2.22	1.71	1.78	0.93	1.10	1.38	0.90	0.89	0.16	0.67		
Actual ins. available water remaining under each 3-6 ft. profile ..	2.91	3.35	2.34	2.07	2.18	1.85	1.91	2.29	2.08	2.23	0.05	1.83		

Comparison of Moisture Storage and Utilization Effects under various Crop Treatments at 0.3 ft. and 3-6 ft. Levels at the end of 1955, 56 and 1956, 57 Dry Seasons

Measurements	Maize		Tobacco		Maize		G-nuts		Bare fallow		Teff		Volunteer cover	
	Nov. 1956	Nov. 1957	Nov. 1956	Nov. 1957	Nov. 1956	Nov. 1957	Nov. 1956	Nov. 1957	Nov. 1956	Nov. 1957	Nov. 1956	Nov. 1957	Nov. 1956	Nov. 1957
Actual ins. water in 0-3 ft. profiles	7.49	6.26	7.04	6.82	6.13	6.46	6.12	6.22	5.81	5.54	6.20	5.84		
Actual ins. water in 3-6 ft. profiles	8.81	8.49	8.20	7.83	8.35	8.23	8.14	8.23	7.35	7.19	6.28	7.06		
Calc. ins. water in each 3 ft. of profile at F.C.	11.01			11.01		11.01		11.01		11.01		11.01		
Calc. ins. water in each 3 ft. of profile at W.P.	6.84			6.84		6.84		6.84		6.84		6.84		
Calc. ins. available water between F.C. and W.P. for each 3 ft. of profile	4.17			4.17		4.17		4.17		4.17		4.17		
Actual ins. available water remaining under each 0-3 ft. profile ..	0.65	-0.58	0.20	-0.02	-0.71	-0.38	-0.72	-0.62	-1.03	-1.30	-0.72	-1.00		
Actual ins. available water remaining under each 3-6 ft. profile ..	1.97	1.65	1.36	0.99	1.51	1.39	1.30	1.39	0.51	0.35	-0.56	0.22		

F.C. Field Capacity W.P. - Wilting Point.

DISCUSSION

(1) The fact that there is available moisture remaining under all treatments at the end of both wet seasons between 0–3 feet, with particularly large amounts under the cultivated crops, demonstrates that the rainfall at Chitedze in the normal season is more than adequate for all crops with regard to their consumption. Variations in consumption for the different treatments between 0–3 feet, are clearly demonstrated and to a lesser extent between 3–6 feet. The amounts remaining under groundnuts, maize and tobacco are somewhat higher than might be expected, probably because of uptake of water due to rain after the various crops had been removed.

(2) The effect of ridging of the three cultivated crops on retention and increased acceptance of moisture is also clearly shown when their available moisture supplies at the end of the wet seasons are compared with those of bare fallow, which was not ridged, and where much of the rainfall was lost due to run off.

(3) The dry seasons table shows, as expected, progressive loss of moisture under all treatments, though this is considerably greater under teff and volunteer cover than for any of the others. All profiles were reduced to wilting point between 0–3 feet, while those of teff and volunteer cover either reached wilting point between 3–6 feet or approached it very closely, and show very markedly the effect of continued root growth during the dry season on both these treatments. Although this effect under teff is the opposite from that originally intended, namely, to conserve moisture during the dry season while providing a cover, the probable reason for this in both seasons is the population density of the crop produced, the initial seeding rate in both years being much too high, and the subsequent competition for moisture causing much greater rooting depths than one obtains with a low seeding rate.

(4) It should be stressed that the harmful effects of indigenous weed cover on the survival of a subsequent crop can only be fully appreciated in a region where rainfall is the major limiting factor to plant growth. Under these conditions some carry-over of moisture from the previous season's fallow treatments might well mean the difference between a crop and no crop at all.

PRECIPITATION AND WATER LOSS

The frequent soil moisture sampling throughout the 1956/57 season, apart from producing a reasonably accurate estimate of amounts of moisture held under the different crops at any particular time, also enabled the relationship between total rainfall precipitation and water loss, due to a combination of run off, percolation and evapotranspiration, to be studied for the various treatments, as shown in the figure at the end of this report.

The graph shows that with the onset of the first heavy rains all the treatments gained water, the gains being proportional to the original water deficit at the end of the 1956 dry season. As plant growth commenced, however, even though initially the amount of rainfall only decreased slightly, it soon became less than the water being lost, due mainly to percolation and evapotranspiration, and from the middle of February onwards the rainfall was never able to catch up with the water lost. Periods of maximum accelerated water loss varied for the different treatments and this occurred first between March and April under volunteer cover, and April and May under all treatments, with the exception of maize, where the loss was greatest between May and November.

All points on the loss side of the graph should be taken to mean losses of moisture from the treatments irrespective of whether the lines joining them have a positive, zero, or negative gradient. Similarly, all points on the gain side of the graph are taken to mean gains of moisture. It is only the speed of the loss or gain which is indicated.

B. MOISTURE STUDIES AT OTHER STATIONS

Throughout the season visits were paid, from time to time, to the Tung Station (Bvumbwe), Tea Station (Swazi) and the Cotton Station (Makanga) where further moisture blocks were installed in connection with the several investigations into the moisture relationships of the various crops grown at these stations, which are at present being carried out.

Other departments are becoming interested in these activities and during the year a series of blocks was installed for the Forestry Department at Nchisi.

It is hoped to report more fully on some of the results of this work next season.

REPORT OF THE ECOLOGIST

The Chileka Catchment

Following on the survey of the Lunzu-Lirangwe-Linjidzi Catchments an area of Zone IV (the Central Belt) was chosen for further developments and a preliminary land-use survey was carried out on the catchment of the Chileka Stream.

The Chileka catchment comprises an L-shaped area of about 5,500 acres. A sizeable acreage is taken up by the aerodrome in the southern horizontal arm of the L. The Chileka Stream itself rises near the aerodrome and flows from east to west for approximately $3\frac{1}{2}$ miles and then flows almost north to join the Nkokodzi River of the Lunzu system. In its upper reaches the river flows through much marshy ground and is often represented by a belt of sedges. Elsewhere it is showing signs of erosive activity and is cutting into the clay bed of the marshes. In its lower reaches the stream flows quite rapidly between high banks which are, generally speaking, well vegetated.

The area is, with the exception of the northern tip, low rolling with stretches of marshland and seasonally waterlogged areas in the valleys and in the wide shallow basins at the headwaters of the drainage lines. The northern section is broken and hilly with dykes which show up clearly on the aerial photographs. Chilangoma Hill is located in the north.

VEGETATION

The vegetation of the area is very mixed and the communities are ill defined.

(1) *Pterocarpus angolensis*-*Terminalia sericea* woodland on red clay loams. This community is very cut-over following cultivation, but the tall trees are left; they include *Pterocarpus angolensis* and *Terminalia sericea* as characteristic trees with *Piliostigma thonningii*, *Afromosia angolensis*, *Burkea africana*, *Diplorrhynchus* sp., and *Combretum* sp.

(2) *Brachystegia boehmii*, *Pseudoberlinia globiflora* woodland with *Diplorrhynchus* sp., *Pseudolachnostylis*, *Terminalia sericea*, *Pterocarpus angolensis* on red clay loams and rocky broken terrain.

(3) *Acacia campylacantha* on black clays.

(4) *Albizzia harveyi*, *Combretum imberbe*, scattered trees on grey clays.

(5) *Scrublands*: *Randia* sp., *Brachystegia boehmii* *Pseudoberlinia globiflora* often on shallow soils or soils overlying laterite.

(6) *Marshlands*: In places good grass swards, with *Paspalum scrobiculatum* in pure stand are found; elsewhere the sward has deteriorated through overgrazing to *Sporobolus pyramidalis*, *Urochloa* spp., *Eragrostis* spp. and *Eriochloa* sp.

The ecological indications are poor but reasonable reliability can be placed on *Pterocarpus angolensis* and *Terminalia sericea* in numbers to be on the better soils. This may, however, be illusive as they are found mixed with *Brachystegia* and *Pseudoberlinia* on both deep red clay loams and on the shallower versions.

Piliostigma thonningii is a fairly reliable indicator of good soils.

Short cut classification to land use types is not possible on the basis of vegetation.

SOILS

1. RED CLAY LOAMS

Deep to fairly shallow soils on rotten rock depending upon site. A typical profile description is given below.

- 0-3" Organic stained dark red-brown clay loam.
- 3-12" Gradual fading of the darker colouration into dark red.
- 12-48" Dark red clay, (2.5 YR 3/6 moist) sand grains apparent in the kneaded sample, structure fine crumb, roots to 48 inches and below into rotten rock. No mottle apparent in the profile.
- 48"+ Rotten rock, with large cracked quartz fragments. Rock black, orange-yellow, grey-yellow mottled, striation in original rock apparent when larger fragments are broken. Much soil in the fissures of the rotten rock.

The depth of the soil varies from site to site but the soil retains a red colour even when very shallow.

The red loams showed no signs of water-logging or unfavourable water relationships.

2. BROWN CLAY LOAMS

Marginal to the above are intermediate soils which do not show the bright red colouration due to poorer water relationships. Their distribution can only be determined by ground survey.

- 0-3" Organic stained dark brown clay loam.
- 3-24" Dark reddish-brown clay.
- 24-30" Dark reddish-brown (5YR4/4 moist) with a red (2.5YR 4/6 moist) mottle becoming apparent.
- 30-36" Mottle of orange-brown, red and grey brown very apparent. Water seeps into the auger borings at between 28 inches and 30 inches. In some profiles black mottling also occurs.

3. BLACK CLAYS

Adjacent to, and along the fairly flat areas along water channels and drainage lines, a black friable clay of varying depth is found.

In the surface it is black, rather greasy when handled; it sometimes has a fine whitish sand wash on the surface. With depth, when slightly better drained, a dark brown and black mottle is observable above the rotten rock. In the wet season of 1957 these clays tended to be waterlogged at about 10 inches to 15 inches and water with green algae lies between the ridges of gardens on this soil type.

4. *Sandy loam upon mottled sandy clays*

In shallow basin areas, particularly when drainage lines arise in a region of low rolling topography, there is a soil type which consists of a sandy soil on an impervious clay.

- 0-9" Organic stained sandy loam.
- 9-18" Dark reddish-brown (5YR 3/2 wet) sandy loam.
- 18-24" Gradually changing to 5 YR 3/4.
- 24-28" Gradual impregnation of sand with clay, soil becomes waterlogged.
- 28-36" Sandy clay loam, red-brown and brown mottle.
- 36-52" Sandy clay to clay, grey with red-brown mottle very moist but not waterlogged.

5. *Grey Clay*

This soil type appears as the soil of the valley bottom, as marshland or as slightly elevated grazing areas. It is a heavy clay which resists water penetration when the cracks, formed in the dry season, have closed. In the slightly elevated sites, which have been used for grazing, water penetration has been limited to a superficial surface layer, probably due to the formation of a puddled layer following heavy cattle concentrations in the rains.

In the profile at varying depth, are white bodies, associated with gravels and very coarse sands which show sign of water action. It is possible that the grey clays and to some extent the clays under sands represent very ancient marshes which have attained their present slightly elevated positions due to recent rejuvenation of river systems. The Chileka River is cutting back in several places along its course.

6. *Red soils overlying laterite*, occur at several places in the catchment. Laterite quarries are found near the headwaters of the Chileka Stream, soils are shallow, tend to less clay, the laterite is of the hardened carapace type breaking up into pea iron fragments. Outcrops occur again on the old Walker's Ferry road and near the turn off to Kuntaja's Court.

LAND USE WITH REFERENCE TO SOIL TYPES

1. *Red Clay Loams*

An arable rotation with minimum period resting ley can be incorporated on these soils, with maize and groundnuts as the basic crops. The resting ley depends upon the ultimate use of the land. If cattle are envisaged the ley should be grass and pigeon pea of at least three years' duration; if no grazing is envisaged then a two year pigeon pea break would suffice.

The red clay loams are remarkably productive in a wet season, no doubt because of their good drainage features. No profile showed signs of waterlogging. Local tradition maintains that they are not so good in a dry year.

On cultivation there is a marked tendency for the clay fraction in the cultivated layers to be removed, leaving a much sandier surface. This is clearly seen on the "rhomboidal" island traversed by Walker's Ferry road. Rain splash picks up the clay fraction very readily and water running off these soils is bright orange-brown.

The shallow phases of this soil are also cultivated under the present system. Soil is literally scraped together to form the ridge. The ridge supports plant growth satisfactorily, at least in a wet season. The rotten rock, where exposed on pathways or roads, exposes a cracked cobblestone surface with numerous fissures, which are filled with soil as profile examination reveals.

The shallow phases of the red clay loams are found on the steeper slopes where the red clay loams change to sands upon clays. The vegetation gives no indication of the change.

2. *Brown Clays*

Although the water relationships are not quite so favourable in a wet year as those of the above, for practical agricultural purposes the brown clays can be included in the above. The brown clays are usually marginal to the red clays and intermediate between them and the black valley type.

3. *Black Clays*

These are the soils that are at present used by the local people for "insurance-against-a-dry-season" garden. To call them *dimba* gardens is a misnomer in that *dimba* gardens are dry season gardens. Even in a wet year with water standing on the

soil surface they are producing remarkable vegetative growth. Local tradition states that crops grown on the black soils are invaluable in years with little rain.

There is some degree of sorting following cultivation as is evidenced by the fine white sand wash found in some gardens.

4. *The Sandy Loam upon Sandy Clay* is the most difficult of the soils from the point of view of land-use planning. The soil profile clearly demonstrates the annual waterlogging that takes place in these soils. That crops are grown quite successfully is probably a function of the ridges which are hoed up in the sandy loam of the surface providing a locally drained site. In the rainy season of 1957 water was found at between 18 inches and 24 inches below average ground level, that is in the sandy loam layers rather than in the clay.

That these soils require a modified system of agricultural practice seems inevitable. Lateral drainage must be encouraged and higher ridges are desirable to effect better local drainage. Groundnuts, however, appear to be thriving in this wet season but the ultimate answer will be found in the harvests. The use of these soils as wet season grazing leys might present difficulties where puddling is to be considered, although the sandy nature of the surface soils should mitigate against this factor. These soils should have a longer resting period, preferably under grass, than the red soils.

Where the sand upon clays or the black clays are found in a situation where water can be held up by bunding they are suitable for rice cultivation.

5. *Grey Clays*

In no situation are these soils suited for any better purpose than dry season pasturage.

At present the grey clays are thoroughly overgrazed as cattle remain on the *dambo*s throughout the year. This is especially so of the slightly elevated areas where trampling and overgrazing have produced such poor cover as to be visible on the air photographs as white patches. The trampling has also puddled and consolidated the surface so that water penetration is reduced to a minimum.

On the wetter areas there is a marked tendency towards *Sporobolus pyramidalis* indicative under these circumstances of overgrazing.

6. *General Indications of Land Usage*

(1) *Arable Lands*—(a) The soil type, best suited to intensive arable agriculture, is the deep red clay. Priority reorganization should be on holdings on this soil type to ascertain if there is place for the movement into it of families on the less favourable sites or alternatively to leave the shallow places for woodlots or permanent pastures.

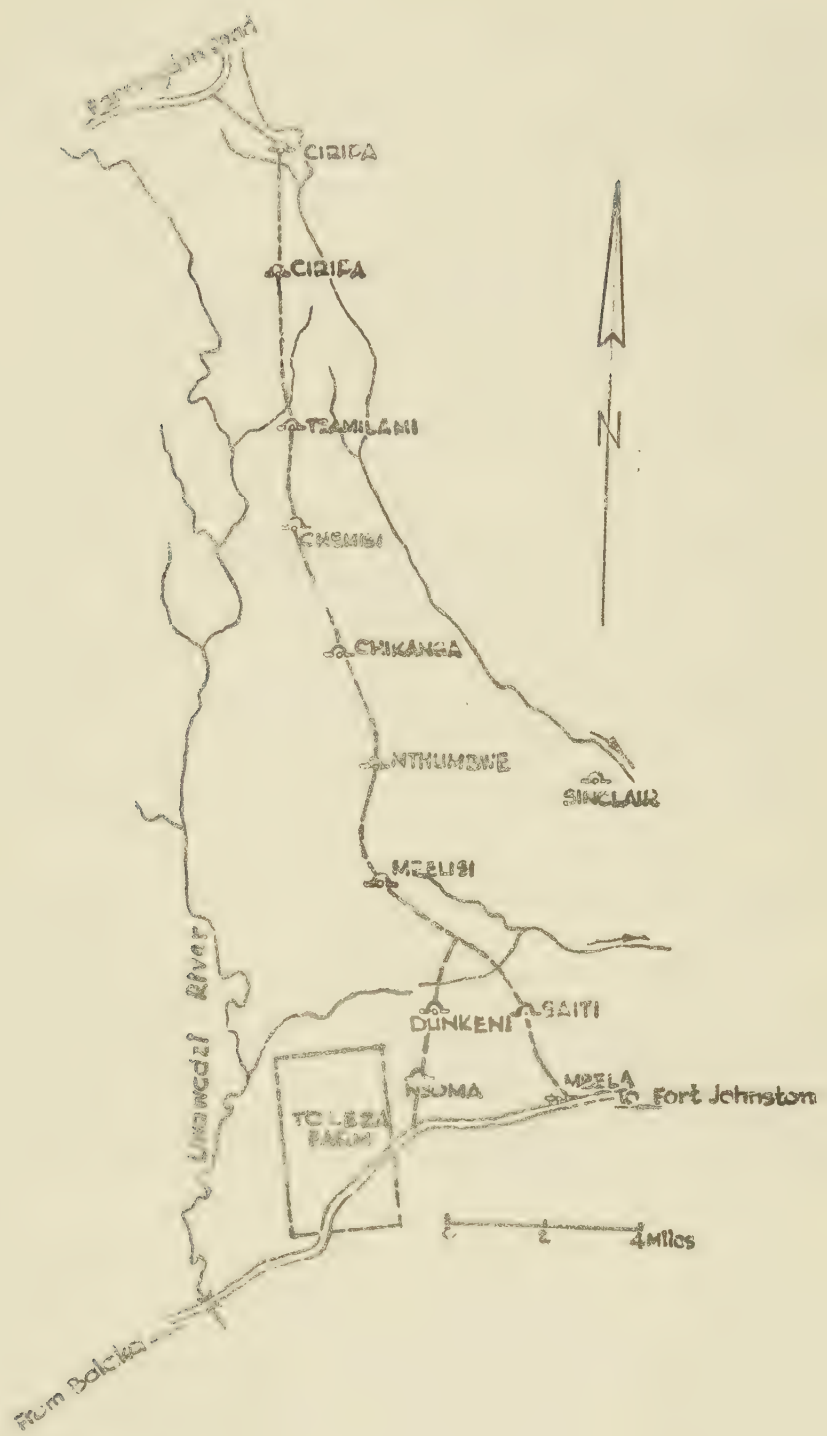
(b) The sand over clay is such a contrasting soil type that holdings should if possible not cover this type and the red clay unless the holding is of such a size to merit individual land use planning.

Shallow soils overlying laterite. Another difficult soil type. Best suited to wet season permanent pasturage. It has been found at Chitedze that grass grown over laterite cuirass does not thrive in the dry season. Mangoes in the Chileka area certainly look rather yellow and unhealthy on the laterites.

(2) *Forestry*—There are several good sites for woodlots.

(a) The shallow places of the red clay would be ideal if it were possible to excise them from the general layout.

(b) This also applies to rocky outcrop areas.



(c) The broken sector in the north could profitably be turned to grazing and forestry.

(d) *Parkia filicoidea* does well in the area; it is a valuable shade tree and provides fodder for cattle. Avenue trees would provide wind breaks and fuel supplies.

(e) Blue gums grow well on the dambo margin soils.

(3) Pastures

(a) Permanent pastures should be located on shallow soils, on the forestry-cum-pasture sites, on the seasonally waterlogged soils and watercourse margins.

(b) Permanent pastures must be supplemented by wet season grazing on grass-pigeon pea leys incorporated in the V.L.I.S.

(c) Indigenous pasture in its present state is poor except for isolated patches of *Paspalum scrobiculatum* and *Echinocloa pyramidalsi*.

(4) The rocky, broken northern sector

This sector will prove the most difficult to plan.

(a) If room can be found elsewhere in the catchment for the inhabitants they could be moved out and the whole sector rested until planned,

(b) At present there is a good deal of patchwork cultivation within it and extensive poor grazing.

(c) Assuming that there is no room elsewhere for the inhabitants the area will require a careful survey and the possible cultivable lands laid out in a sound conservation system.

The valleys and shallow soils will provide permanent pasturage and the rocky slopes woodlots.

Dedza Secondary School

A land-use plan was produced for Dedza Secondary School based upon the following field data.

The lands of Dedza Secondary School lie at the foot of Dedza Mountain and along the border of the Dedza Mountain Forest Reserve.

The estate is shaped like an axe, the blade of which is hilly and broken and constitutes the area of school buildings and residences. This area was not considered in the plain, it is best suited to terraced gardens, orchards, lawns and forestry.

The area considered for planning lies below the present access road to the school. A stream with very steep banks flows through the area effectively dividing the land into two unequal parts.

VEGETATION

There are five main communities.

(1) *Brachystegia floribunda*, *B. longifolia* woodland with *B. spiciformis* and *Protea* sp.

(2) *Acacia* sp. with *Dombeya rotundifolia*, largely cut over and cultivated.

(3) *Uapaca kirkiana* low woodland on shallow soils with laterite or murram.

(4) Swamp grass and sedge land.

(5) Evergreen Riparian Forest along the river banks with *Syzigium* sp. and *Acacia abyssinica*.

SOILS

(a) The better soils are *strong brown clay loams*, very deep with a uniform profile, rock not being reached at over 8 feet in the type pit. The pH varies from 5.8 in the surface to 7.0 at depth. Available phosphate supplies are high but the organic matter and nitrogen are low.

(b) *Dark yellow-brown clays* similar to group (a) but with concretions at between 12 inches and 24 inches.

Both the above soils have good structure, are friable and moisture retaining. The profiles show no signs of waterlogging in group (a) and are well drained. In group (b) a slight mottle is visible below the zone of concretions. They are *good arable soils, high in phosphorous*.

(c) *Yellow-brown clays with murram*. The clay in these soils does not give rise to a good structure, the structure being rather large nutty. The concretions are well distributed at all depths in the profile, there being some increase between 36 inches and 48 inches. The nodules are black when broken. The phosphate status of the soils is still high.

This soil could be used for arable farming but is better suited to permanent pasture because of murram, structure and impeded drainage factors.

(d) *Grey-brown sandy loams* with increasing clay with depth. Concretions and solid laterite at 15–24 inches.

Poor soils with laterite, suitable for pine plantation, except where carapace laterite occurs.

(e) *Grey swamp* soils with permanent seepage.

A small area, suitable for planted winter pasturage.

(f) Soils with high organic matter in the valley bottom. At depth a *blue-grey sandy clay* or *sandy loam* with distinct mottling.

These soils are very valuable if used correctly.

The Lufira Irrigation Scheme

SOILS

A close grid soil survey was carried out on the area north of the Lufira River known as Mwenitete *dambo* or plain. Nearly all the profiles showed a stratification of soils which sometimes varied from heavy clay to coarse sand within a depth of 60 inches. This marked variation in profiles led to mapping difficulties and a method was devised showing the soil types as profile diagrams at the sites of their occurrence. From this plan the pattern of the variation is apparent and the marked stratification of the soils is very clear. The whole history of the soils of the Mwenitete plain is tied up with a complex alluviation by rivers and deposition in swamps and this has given rise to the mosaic of types within a small area.

Stratification of such a degree found at Mwenitete was considered a hazard for irrigation projects.

A second hazard was encountered when a study was made of the pH status of the soils. Several profiles show a rapid change from acid in the surface to high pH with depth. Such pH changes cannot be located at any one place on the plain but are possibly associated with areas where there is no appreciable external drainage. Likewise several profiles show calcium carbonate concretions at depth, which also shows the tendency to salt accumulation. Irrigation without adequate drainage off the area would aggravate the situation.

The third hazard to irrigation is the soil texture. There are very many profiles with heavy clay layers, the clays being of the type which resist water penetration. Where such clays had dried out in the field the profiles demonstrated the angular prismatic structure typical of intractable clays.

It is interesting to compare the profile of the irrigation trial site with the plain in general. The soils which gave such promising results were sandy clay loams on sandy loams with sand at the base of the profile—an ideal soil for irrigation purposes. The surface retains moisture satisfactorily but the more permeable sub-soil strata give good drainage conditions so that excess water can get away and flush any excess salts out of the soil.

Similar soil profiles to those of the trial site are found on the plain but their distribution is such as to preclude an overall system of irrigation. Such soils probably represent river bank soils as is certainly the case with the irrigation trial plot.

Settlement, Tsetse Flies and Boreholes in the Balaka-Fort Johnston Area

In collaboration with the Game, Fish and Tsetse Department and the Department of Geological Surveys a preliminary survey was carried out in the Balaka-Fort Johnston area near Toleza to ascertain if a belt of cultivation was possible along the Ciripa Track; the object being to create a barrier to tsetse fly movement.

PRESENT POSITION

With reference to the map there is well-established settlement to the north of Toleza Farm in Anderson and Toleza villages; to the east, Duncan, Chulu and Mbela are fairly large settlements. Mbela is a village that has been established at this point for some time.

From Mbela and Duncan there is a new track which goes roughly north to Chiripa village on the Farrington road. Recently, new settlement has taken place in a haphazard manner along this track. Mpelisi villagers have moved in the last few years from a site on the Nkazi River and there are several settlements of Africans Cholo, Chiradzulu and Zomba.

For these new settlers water supplies are a serious problem.

TSETSE FLIES

There are concentrations of tsetse flies across the river from Sinclair's settlement in the vicinity of Chikowe Hill. Flies are also taken in numbers from cyclists passing along the Mpelisi-Chiripa track.

One fly was seen on Toleza Farm near the northern boundary of the cultivations.

SETTLEMENT

Ideally, settlement from Sinclair east would disturb the tsetse fly in this area but the situation with regard to proper land utilization would hinder such a plan. The soils are reasonable red-brown gritty clay loams but, as at Sawale Village, which lies to the south of the Balaka-Kalembo road, there is a serious erosion problem. The areas of red brown gritty clay loams often demonstrate serious natural erosion features which would be aggravated by uncontrolled settlement. In the area east of Sinclair there are numerous steep-sided, eroding valleys and active gullies.

From Sinclair west the soils are varied but are generally sandy in nature with more or less clay impregnation. They are often shallow over laterite and many profiles show clear mottling suggesting impeded drainage in the rains. Despite the fact that the soils look unpromising at first, the local inhabitants declare that they are realizing good maize crops. Groundnuts should grow well in these sandy

soils. (The soils closely resemble those of the North Chilwa area.) Added to this there is already settlement in this area following the Mbela-Mpelisi-Chiripa track which could be the basis for a pattern of extended settlement to provide a corridor of cultivation from the Balaka-Kalembo road to the Farrington road.

As there is considerable movement along this road and tsetse flies having been directly associated with the traffic, extended cultivations should prove a distinct disturbance factor to the flies and help to reduce transfer of fly to the Balaka area.

BOREHOLES

The strategic siting of boreholes along the Mpelisi-Chiripa track would encourage settlement in the right area but due regard must be given to correct land use on soils which are not exactly first class. With care there is no reason why these soils should not be productive, especially of groundnuts. The organic status must be maintained by proper rotation.

REPORT OF THE PLANT PATHOLOGIST

NEW RECORDS

During the year, the following new records were made. Some of these are still subject to authoritative determinations:

Crotalaria juncea L.

Wilt—*Fusarium* sp., possibly *vasinfectum*.

Gossypium hirsutum L.

Leafspot—*Phyllosticta gossypuina* Ell. & mart.

Nicotiana tabacum L.

Anthraxnose—*Colletotrichum tabacum*. Boning

Nicotiana tabacum L. var. Turkish.

Scab—*Septomyxa affinis* (Sherb) Wallr.

Leafspot—*Alternaria longipes* (Ell. et Ev.) Mason.

Frog Eye—*Cercospora nicotianae* Ell et Ev.

Mildew—*Erysiphe cichoracearum* DC.

Mosaic—Tobacco mosaic virus.

Psidium guajava L.

Leafspot—*Pestalotia psidii* Pat.

Associated with angular leaf spot ascribed to injury caused by *Helopeltis* sp. feeding punctures.

Algal spot—*Cephaleuros mycoidea* Karst.

NOTE.—See also under crop sections for reports on diseases.

REPORT OF THE ENTOMOLOGIST

SORGHUM

The sorghum midge (*Contarinia sorghicola* coquillet) has been collected in Zomba District, and is a new record for Nyasaland. This midge causes severe damage to sorghum in Nigeria. A species of *Contarinia* has also been collected from the grass *Hypparrhenia rufa*. Trials are planned to see if this is the same species as occurs on sorghum.

STORED PRODUCTS

An outbreak of the tobacco beetle (*Lasioderma serricorne* F) occurred on the auction floors in Limbe; the outbreak was traced to one estate and timely fumigation stopped any further spread of the pest.

Trogoderma granarium L has fortunately been conspicuous by its absence in the bulk maize stores of the Agricultural Production and Marketing Board. In general the state of the maize in these stores has been excellent and regular sampling has yielded very few live insects. Where maize had been in store for about fifteen months and was fumigated a second time after nine months, it was still in good condition. This maize is being sampled regularly as the stocks are being broken down.

NOTE:—See also under crop sections for reports on pests.

